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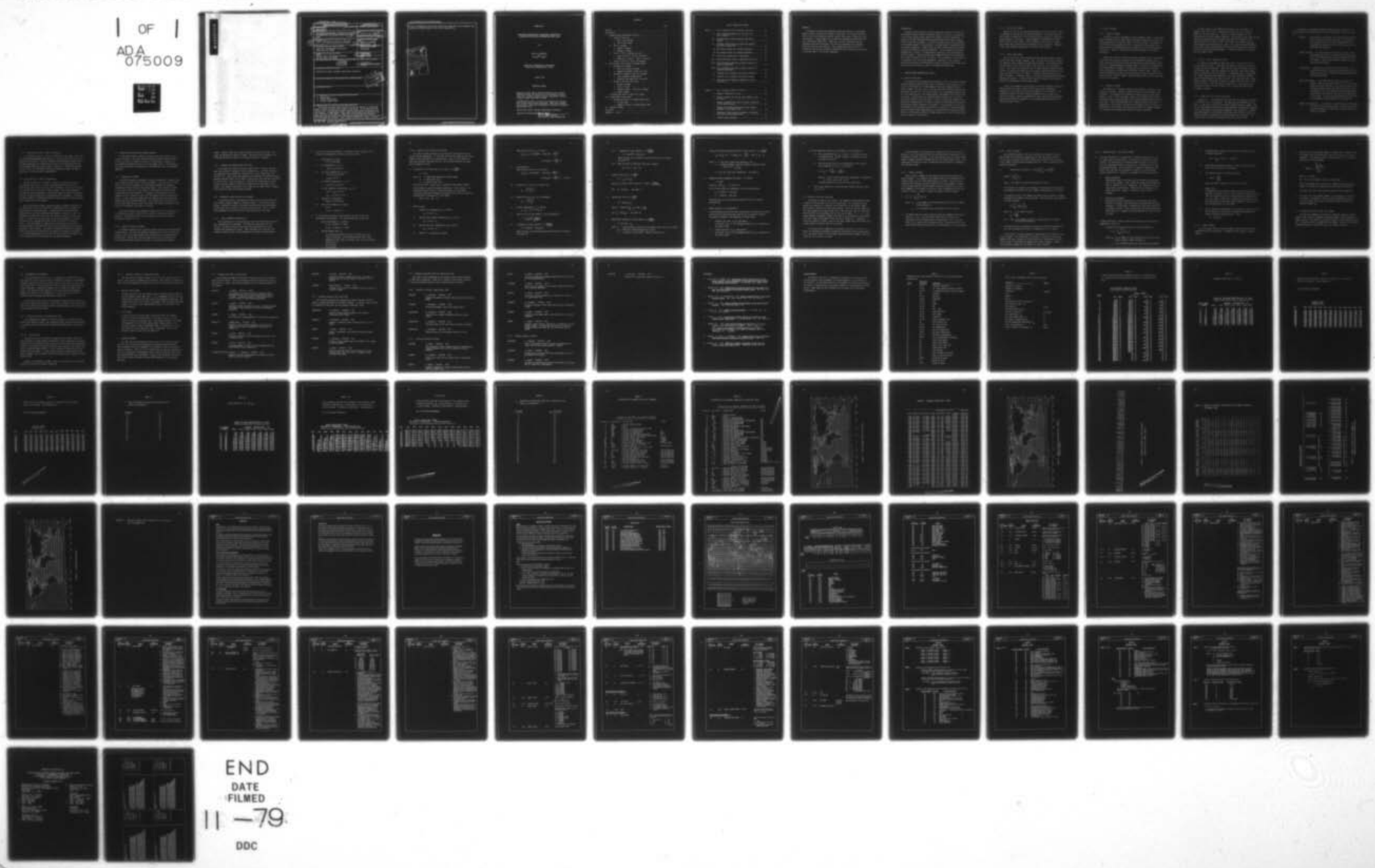

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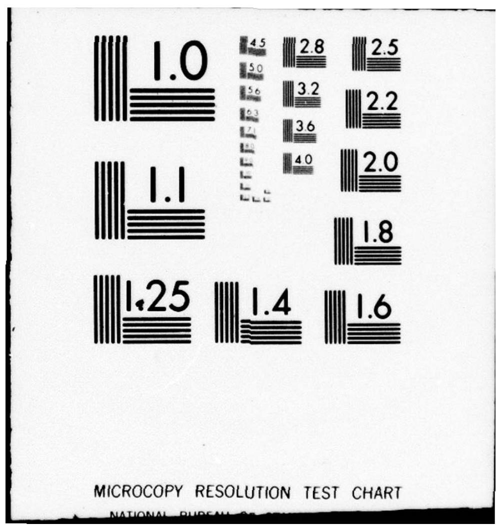
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Scientists at Woods Hole routinely collect and analyze a considerable amount of data relating to the oceans of the world. Of the many different kinds of data, one particular subset concerns those events occurring at the sea surface. A large number of sea surface environmental observations have been collected at Woods Hole. These data, and the subsequent analyses generated from the Air/Sea Heat Flux and the Climatology study projects, have been collected and archived. This document describes the (Cont. on back)

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WHOI-79-70

WOODS HOLE OCEANOGRAPHIC INSTITUTION COLLECTION OF CLIMATOLOGY AND AIR/SEA INTERACTION (CASI) DATA

by

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and
Andrew F. Bunker

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TECHNICAL REPORT

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Approved for Distribution Earl E. Hays

Earl E. Hays, Chairman
Department of Ocean Engineering

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ABSTRACT

Scientists at Woods Hole routinely collect and analyze a considerable amount of data relating to the oceans of the world. Of the many different kinds of data, one particular subset concerns those events occurring at the sea surface. A large number of sea surface environmental observations have been collected at Woods Hole. These data, and the subsequent analyses generated from the Air/Sea Heat Flux and the Climatology study projects, have been collected and archived. This document describes the W.H.O.I./Climatology and Air/Sea Interaction (WHOI/CASI) data collection and provides an initial index to its various components.

INTRODUCTION

During the last few years, several researchers at Woods Hole have used the National Climatic Center's Tape Data Family-11 (TDF-11), a collection of world-wide surface marine observations made by ships of opportunity. A variety of studies have been made using these data but the most extensive work has been done by Bunker. A series of related projects have performed a considerable amount of processing on a selected group of atmospheric and sea surface parameters. Energy fluxes and wind stresses have been computed by empirical formulas from those parameters. All the parameters have been averaged over a variety of climatological conditions, areal distributions, and time periods. These data have been assembled to build the Climatology and Air/Sea Interaction (CASI) collection. The information in this data set is available to all marine and atmospheric scientists. This document defines the contents of the WHOI/CASI archives, describes how to access and use the data, and reports on some of the analyses already done.

I. SURFACE MARINE OBSERVATIONS (TDF-11)

I.A Source of the data

The surface marine observations residing at W.H.O.I. have been obtained from the National Climatic Center (NCC) at Asheville, North Carolina. NCC is one of the centers in the Environmental Data and Information Service (EDIS) of NOAA. The major part of the data has been extracted from the Tape Data Family-11 (TDF-11). This data series is in a standardized format used to record observations of the surface marine environment from a wide variety of sources. The NCC data set, from 1854-1968, contains over 31 million observations from all over the world. The NCC is continually adding to this data base, although there is a lag of a couple of years before any group of observations becomes available to the public. If the region or time period of interest is not available in the W.H.O.I. collection, it may be obtained from the regional NOAA representative or directly from the National Climatic Center. We will make an effort to merge future W.H.O.I. users' acquisitions into the archive if they desire.

I.A.1 TDF-11 data content

Because the TDF-11 has been assembled from a variety of sources, there is available no uniform set of selected parameters. In general, only the data present in characters 1-72 of each record are available in sufficient enough quantity to be useful. These parameters are summarized in Table I. The last part of each record is apt to contain a wide variety of supplemental data whose content must be determined from a flag field. Appendix A gives a more complete description of the TDF-11 data content.

I.A.2 TDF-11 data format

Most of the TDF-11 series obtained from the National Climatic Center is stored on 9-track, 800 bpi, magnetic tape. The data are usually stored as 140 character (byte), EBCDIC, blocked logical records. The blocking factor may vary from 1 to 40; the NCC label on the reel will give the blocking factor. The records are ordered by the 10° square Marsden reference number. Within a 10° square the observations are usually ordered chronologically by year, and within the year, by month. A tape may contain data for one or more 10° squares. In general, there is no end-of-file mark between data from separate 10° squares. It has also been found that there is not always an end-of-file mark before an end-of-tape signal.

Table I also summarizes the location of the more frequently used parameters within the record. Many of these fields contain additional information in the form of a logical byte addition, or "overpunch". This technique is used by the NCC to carry information such as minus signs. Users of the TDF-11 tapes are encouraged to first read the detailed format description contained in Appendix A, or documentation obtained from the National Climatic Center.

I.B TDF-11 coverage

I.B.1 Spatial coverage

The TDF-11 series is arranged by areas 10 degrees square. As these are marine observations only, many areas will contain large areas of land, and thus represent only a relatively small area of sea surface. The subset of the TDF-11 series available at W.H.O.I. covers most of the Atlantic and Indian Oceans, the Mediterranean and the Red Seas, and selected regions of the Pacific. Figure 1 illustrates the spatial coverage of the current collection.

Within any single 10° square the spatial coverage may vary considerably. Observations are generally confined to the established shipping lanes. A finer resolution of position may be obtained from the data records, either from the 1° subsquare Marsden reference number, or from the latitude/longitude coordinates (0.1 degree). The WHOI/CASI collection also contains marine observations recorded from "stationary" weather ships. These are recorded separately and have not been merged into ship-of-opportunity files. These files are in TDF-11 format, ordered chronologically by year and month, but not by 10° squares.

I.B.2 Temporal coverage

Observations of the marine surface conditions date from 1854 in some regions of the world. However, coverage in the early years tended to be infrequent. The frequency of observations varies widely over the ocean surface. Local, as well as global, events in the economic and policital environment have a large influence on the recorded observation rate for any given area. Thus, both World Wars saw a marked increase in the rate of observation. The closing of the Suez Canal produced a drop in the rate of observation in the Red Sea, and the advent of large oil tankers produced an increased rate of observation around the Cape of Good Hope.

For most regions in the WHOI/CASI collection, the time range is commonly from 1942 to 1972. (Supplementary tapes have been obtained to update the record through 1976. These have not been appended to the existing series, but are grouped separately. See the TDF-11 tape index for tape identifiers and Marsden square ranges covered by these updates.) The index to the W.H.O.I. TDF-11 series (see section I.C.1 below) contains a time range for the observations on a tape. This range has been determined from several sources and represents the earliest and latest dates revealed using the various processing programs. It does not necessarily represent the full range of time.

I.C W.H.O.I. TDF-11 storage and access

An effort has been made to gather the W.H.O.I. TDF-11 series into a central storage facility. Most tapes are currently located in tape racks in room 358, Clark Laboratory. There does not exist any formal system for accessing the data. Users are requested to take only those tapes needed and to return them as soon as possible. A withdrawal form is located near by; please supply the tape identifier, your name, telephone extension, date of tape withdrawal, and date of return. For cases where only a small number of tapes, or portions of tapes, are needed, users may wish to copy the TDF-11 tapes to their own tapes or disc files. This procedure will increase the life of the TDF-11 tapes as well as make tham more readily available to others.

I.C.1 Index to W.H.O.I. TDF-11 collection

Located in room 358 along with the data tapes is an index of the data in the W.H.O.I. TDF-11 collection. The data are cross-referenced in two ways: 1) the first index lists the data by Marsden reference number. This is, for most purposes, identical to being ordered by latitude and longitude. 2) The second index lists the data by magnetic tape identifier. As these tapes were labelled in the order in which they were received, there is no reliable method of identifying the data from the tape identifier. This index is used as an aid in determining what else is on the tape.

In addition to the Marsden reference number and tape identifier, the following data are available from the index (an example is shown in Figure 2):

- Position: The position is expressed as the latitude and longitude of the center point of the 10° square. Latitudes contain the suffix N or S to denote hemisphere and the longitudes are suffixed with E or W with respect to the Greenwich Prime Meridian.

- Storage location: The location where the data are stored. Some investigators may choose to keep custody of their tapes while still making the data available through the WHOI/CASI archive. These tapes should be obtained from the associated investigator.

- Investigator: Identifies the contributor of the data tape. This person may be able to answer questions pertaining to the contents of the tape, or may have information bearing on your current project.

- Start and End Dates: An attempt has been made to estimate the temporal range of the data contained on the tape. These figures have been obtained as a by-product from previous processing efforts rather than from any specific search. The dates are in no way connected with the frequency of observations, and should be used only as a rough guide to the range. (Any new values encountered by users will be incorporated if made available to the authors.)

- Number of observations: In some cases a rough estimate of the number of observations has been provided. Again, these figures have been obtained as a by-product of other work and are merely an estimate.

I.C.2 Additions to W.H.O.I. TDF-11 collection

It is hoped the W.H.O.I. TDF-11 collection will meet some of the need for obtaining oceanographic data quickly. If the desired TDF-11 data is not present in the archive, it must be obtained from the Nation Climatic Center. The NOAA representative at Woods Hole can aid you in obtaining these data. The subsequent addition of TDF-11 data to the W.H.O.I. collection would be welcome. Also, any information which would update the index, and make it more useful to others, would be appreciated.

I.D Using the W.H.O.I. TDF-11 observations

The TDF-11 data series represents a great many observations over a considerable span of time. As such, the observations may be used for constructing time series of events, such as monsoons, as well as for looking at long term (25 and 100 years) climatic trends. Most observations have been made by ships of opprotunity; Fieux and Stommel (1) have discussed the accuracy of these observations in representing the environment. In general, the sheer quantity of observations makes the data suitable for most projects where average results are desired.

While the National Climatic Center has made an attempt to validate all the observations, users are cautioned to perform their own reasonability tests before or during processing. Instances have been recorded where temperature has not been converted from Fahrenheit to Celsius. Other discrepancies, although also rare, have been found in almost all other parameters. For this reason, and because of the involved format of the data, no general access programs have been written for the TDF-11 series at W.H.O.I. The large number of parameters per record and the use of the "overpunch" make it more efficient for users to interpret only those fields necessary to their studies. The format is adequately described in Appendix A and IPC personnel can provide aid in decoding the records if necessary. It is further recommended that the user list a few records of a tape to aid in the interpretation of the format and in program development.

II. AIR/SEA HEAT FLUX ANALYSIS (PROGRAM ASHFLA)

In 1973 Andrew Bunker initiated a study of the energy fluxes at the air/sea interface. This study used observations from the Tape Data Family-11 (TDF-11) series to compute a variety of climatological averages for environmental parameters as well as for the energy fluxes. The results of this project have been incorporated into the WHOI/CASI files as the ASHFLA component.

II.A Background for ASHFLA

The ASHFLA program was developed to study the mechanism of energy transport between the ocean surface and the atmosphere. Over the course of the project the analysis procedure was occasionally changed to incorporate information learned in earlier processing stages. These changes included a) the effect of sea ice on the albedo, b) the effects of clouds on the incoming and long wave radiation, c) changes in the parameters used and summarized, and d) changes in units (SI) associated with the computed parameters. In most cases the changes have not affected the results which are incorporated into the WHOI/CASI files. The climate study (see Section III below) which ensued from the heat flux project has further standardized that portion of the ASHFLA files which it utilized.

The project generated an abundance of data, which will be discussed in the following sections. ASHFLA data are stored in volumes of computer printout. An interpretation of at least portions of the data has been published by Bunker (2, 3, 4).

II.A.1 Heat flux spatial coverage

The ASHFLA program initially studied a small region of the western North Atlantic Ocean. The study was gradually enlarged to cover all of the North Atlantic, most of the South Atlantic and Indian Oceans, the Mediterranean and Red Seas. Studies have also been made, based on the contribution of TDF-11 data from other projects, for parts of the Pacific and Southern

Oceans. Figure 3 shows those areas covered by the heat flux study. The study was conducted on areas 10° square. There was also the capability to subdivide the area into from 1 to 10 regions based on 1° squares.

II.A.2 Temporal coverage of heat flux files

As the heat flux study was derived from the TDF-11 series, the time range was primarily a function of the available data. A further constraint was imposed by the reasonability checking done on each observation (see Section II.B). Heat fluxes were computed for individual 10° squares starting anywhere from the 1920's to the 1950's; ending dates were from the late 1960's to 1973 or 1974. The time range for a selected 10° square region is best obtained from the summary of monthly averages near the beginning of each volume. The temporal resolution of the study was one month using a standard 30-day month for some of the annual averages.

II.B Parameters studied in heat flux program

As mentioned earlier, the study of the heat flux at the air/sea interface evolved through a number of different stages. In the outline which follows, reference is made to the latest version of the study and computer program under which the bulk of the data were processed. Table II shows those parameters in the TDF-11 series which were used in the study.

II.B.1 Input parameter acceptability

The reasonability of the observational data was tested before any heat flux computations were performed. The data were broken down into two classes; variables critical to the heat flux computations must have satisfied the reasonability check. Those variables not as crucial were assigned a default value if the acceptability condition was unsatisfied.

a. All of the following variables, in addition to being reported, had to satisfy the reasonability conditions ascribed below.

i Wind Speed, W in knots

$0 \leq W \leq 199$ knots

ii Air Temperature, T_a in °C

$-40.0° \leq T_a \leq 45.0°C$

iii Dew Point Temperature, T_d in °C

$-70.0°C \leq T_d \leq 40.0°C$

$(T_a - T_d) \geq 0.1°C$

iv Sea Surface Temperature, T_s in °C

$-5.0°C \leq T_s \leq 40.0°C$

v Air-Sea Temperature Difference, T_{as} in °C

$-40.0° \leq T_{as} \leq 20.0°C$

$|T_{as} - (T_a - T_s)| \leq 1.0°C$

vi Pressure, P in millibars

$890.0 \leq P \leq 1070.0$ mb

vii Total Cloud Amount, N_T in oktas

$N_T \leq 8$

if $N_T > 8$ then $N_T = 8$

b. If the following variables were missing or did not satisfy the acceptability requirements, they were assigned the stated value.

i Lower Cloud Amount, N_L in oktas

If N_L = blank $N_L = 0$ oktas

If $N_L > 8$ oktas $N_L = 8$ oktas

ii Present Weather Code, W_c

If the present weather code was left blank, a no rain state was assumed. The following weather codes (from Appendix A) were taken to indicate rain, or more correctly, precipitation.

$14 \leq W_c \leq 29$

$50 \leq W_c \leq 99$

II.B.2 Equations and quantities calculated

The item of primary interest was the net heat flux between the sea surface and the atmosphere. In the study the net flux comprised the latent, sensible, and radiational flux contributions. Each of these terms has additional measures associated with it; this section describes the mathematical expressions used.

a. Calculation of net heat gain by the ocean, A in $\frac{\text{watts}}{\text{meter}^2}$

$$A = R - LE - S$$

where R is radiational exchange at ocean surface

LE is latent heat flux

S is sensible heat flux

The quantity $A(B) = R_B - LE_B - S_B$ is calculated using Budyko's method, which assumes a constant exchange coefficient. (See h below.) An additional quantity A(B,I) is calculated which uses the Budyko calculated radiational exchange and average fluxes based on individual observations as indicated in c and d below:

$$A(B,I) = R_B - LE_I - S_I \quad .$$

b. General terms

i Absolute air temperature, θ_a in °Kelvin

$$\theta_a = 273.16 + T_a$$

ii Absolute sea surface temperature, θ_s in °Kelvin

$$\theta_s = 273.16 + T_s$$

iii Absolute dew point temperature, θ_d in °Kelvin

$$\theta_d = 273.16 + T_d$$

iv Pressure, P, converted to Pascals

v Vapor pressure of air, e_a, Pascals

$$\log_{10} e_a = 10.42926609 - 1.82717843 \left(\frac{1000.0}{\theta_d} \right) - 0.071208271 \left(\frac{1000.0}{\theta_d} \right)^2$$

vi See Reference 6

Vapor pressure over sea, e_s, Pascals

$$\log_{10} e_s = 10.42926609 - 1.82717843 \left(\frac{1000.0}{\theta_s} \right) - 0.071208271 \left(\frac{1000.0}{\theta_s} \right)^2 - 0.008774$$

vii Mixing ratio of air, q_a in grams/gram

$$q_a = \frac{0.622\ e_a}{P - e_a}$$

viii Mixing ratio over sea, q_s in grams/gram

$$q_s = \frac{0.622\ e_s}{P - e_s}$$

ix Virtual temperature, T_v in °Kelvin

$$T_v = \theta_a \cdot (1.0 + 0.61\ q_a)$$

x Density of air at the surface, ρ in kilogram/meter^3

$$\rho = \frac{P}{T_v \left(287.04\ \frac{\text{Joules}}{\text{kg}\ {}^\circ\text{K}}\right)}$$

xi X component of wind velocity, U in $\frac{\text{meters}}{\text{seconds}}$

$$X = W \cos[270° - f(D_1,D_2)]$$

where $f(D_1,D_2)$ is the direction from which the wind is blowing. See Table III.

xii Y component of wind velocity, V in $\frac{\text{meters}}{\text{second}}$

$$Y = W \sin[270° - f(D_1,D_2)]$$

where $f(D_1,D_2)$ is the direction from which the wind is blowing. See Table III.

xiii Mean direction of resultant wind, MD in degrees

$$MD = 270.0 - \tan^{-1} V/U$$

c. Sensible heat flux, S in $\frac{\text{watts}}{m^2}$

$$S = -T_{as}\ \rho\ W\ C_p C_e$$

where C_p = specific heat of dry air = 1004.64 $\frac{\text{Joules}}{\text{Kg °Kelvin}}$

and $C_e = f(W,T_{as})$. See Table IV.

d. Latent heat flux, LE in $\frac{\text{watts}}{m^2}$

$$LE = L\rho WC_e(q_s - q_a)$$

where $L = 2500297.8\ \frac{J}{kg} - T_a \cdot 2365.09\ \frac{J}{kg°C}$

and $C_e = f(W,T_{as})$. See Table IV.

e. Radiational exchange at ocean surface, R in $\frac{\text{watts}}{\text{meter}^2}$

$$R = Q(1.0-\alpha) - I_R$$

where Q = solar radiation received at the surface (see II.B.2.h.iii below),

I_R = effective infra-red radiation of ocean,

α = a function of the albedo $[f(m,\phi)]$ from Table V.

f. Effective infra-red radiation emitted by ocean surface, I_R in $\frac{\text{watts}}{\text{meter}^2}$

$$I_R = B\sigma\,\theta_a^4\,(11.7 - 0.0023e_a)\cdot(1 - \frac{C\cdot N_T}{8.0}) + 4B\sigma\,\theta_a^3\,(\theta_s - \theta_a)$$

where B = fraction of black body radiation, 0.96

σ = Stefan Boltzmann's constant (Budyko's modified value)

$1.3134 \times 10^{-9}\ \frac{W}{m^2\ {}^\circ K^4}$

C = f(ϕ) the cloud cover coefficient. See Table VI.

g. Momentum between atmosphere and ocean, τ in Pascals

$$\tau = \rho C_D W^2$$

where $C_D = f(W, T_{as})$. See Table VII.

This is broken down into components in the following manner:

$$\tau_X = \tau\cdot\cos[270 - f(D_1, D_2)]$$

$$\tau_Y = \tau\cdot\sin[270 - f(D_1, D_2)]$$

where $f(D_1, D_2)$ is the direction from which the wind is blowing. See Table III.

h. Budyko equations (see Reference 7)

In calculating the heat flux terms using Budyko's coefficient, average values for the time period were used for all the general variables. The specific changes in the equations are noted below.

i Sensible heat flux, S_B in watts/meter^2

In section II.B.2.c, the exchange coefficient C_E is replaced by the value 0.0021.

ii Latent heat flux, LE_B in watts/meter^2

In section II.B.2.d, the exchange coefficient C_E is replaced by the value 0.0021.

iii Solar radiation received at the surface, Q in watts/meter^2

a) The calculation of Q_0, $Q_0 = f(m,\phi)$, is a function of the latitude and time. Q_0 for a monthly calculation is given in Tables VIIIa and b.

b) The calculation used in the determination of the surface solar radiation II.B.2.e, is as follows.

$$Q = Q_0(1.0 - \frac{A_c \overline{N}_T}{8.0} - B_c(\frac{\overline{N}_T}{8.0})^2)$$

where $A_c = f(\phi)$, is the cloud cover coefficient. See Table IX.
$B_c = f(\phi)$, and is set = 0.38 .
Average values are used for the total cloud cover.

iv The average albedo for all observations replaces the table value in II.B.2.e.

II.C Output of the heat flux study

Processing was done by 10° squares. The computer program produced about 75 pages of listed output for each 10° square area. The listings for each square are contained in a separate volume identified by the Marsden number. Each volume is divided into three main sections. The first section summarizes the input parameters and data tables used in the analysis. Most of these have been described in the preceding section II.B and in Tables II - IX. A 1° sub-square regional assignment diagram is printed at the beginning of each volume. This chart shows the breakdown of the (up to) 10 regions by 1° subsquares within the larger 10° square. Most of the later volumes also contain the area (square meters) covered by each of the regions.

The second section summarizes the averages (sections II.C.1 and II.C.2 below) for selected environmental parameters and energy fluxes by month and by year. The third section is the seasonal region/wind sector summary, contained in section II.C.3 and II.C.4 below.

A fourth output of the program was a punched card file of the monthly averages. This file forms the basis for the subsequent climatological files, discussed in section III below. As of this writing, only the Atlantic Ocean monthly averages have been incorporated into the climatological files. The remaining 10° squares are still in punched card form and will be updated as time and money allow.

II.C.1 Monthly averages

Table X gives a summary of the variables output for the monthly and yearly averages. All variables are average values or are calculated using average values, over all valid observations in a month. The use of the estimated mean technique was made necessary by the large number of observations processed and the limited computer resources available at the time. This component of the output is also used in the climatological files (see section III below). Figure 4 contains an example of these averages.

a. $\bar{X}_m = X_e + \frac{1}{n_m} \sum_{i=1}^{n_m} (X_i - X_e)$

where n_m is the number of valid observations for the month (output variable number 4)

X_e is an estimated mean value unique for each variable.

b. The Budyko heat flux terms are found using the assumptions outlined in section II.B.2.h. All the general terms used in the heat flux expressions are the average values as determined in II.C.1.a above. Table VIII is used in the calculation of Q_0. The mid-latitude of the region being summarized was used in the interpolation for a given month.

II.C.2 Yearly averages

The variables output for the yearly averages are almost the same as those output for the monthly averages and are also described in Table X. For the yearly average, field three contains the coefficient of variation of the number of observations throughout the year. This is found using the following expression:

a. $$\text{coefficient of variation} = 100.0 \left(\frac{1}{12} \sum_{m=1}^{12} (n_m - \bar{n})^2 \right)^{\frac{1}{2}} \Big/ \bar{n}$$

where $\bar{n} = \frac{1}{12} \sum_{m=1}^{12} n_m$

and n_m = the number of valid observations for a month.

b. The frequency of rainfall is the number of observations which recorded precipitation divided by the total number of observations in the year.

c. The remaining terms in the summary are found using the monthly averages weighted by the number of days per month. The results are then expressed as 30-day averages.

$$\overline{X}_Y = \sum_{m=1}^{12} (a_m \overline{X}_m) / \sum_{m=1}^{12} a_m$$

where $\overline{X}_m$ is the monthly average

$$a_m = \frac{f(m)}{30}$$

and $f(m)$ is the number of days in a given month for all months with valid observations.

d. The wind direction is determined from the east and north components of the yearly average wind velocity as computed by II.C.2.c above.

The net result is that the number of observations has no effect on the yearly averages. The coefficient of variation (in field 3 of the annual summary) does give a measure of the distribution of observations over the year in order to facilitate the comparison of yearly averages. Figure 4 also contains an example of the summary of yearly averages.

II.C.3 Seasonal region - wind sector summary

a. Each valid observation is classified by a regional subdivision of the 10° square and by the wind sector, or direction from which the wind is blowing. All observations are further grouped by season of the year. Thus, all observations made in a season (e.g., January) over all years are grouped together. In this analysis, a season was defined for each month of the year and this assumption is implicit in the weighting factors defined below. Figure 5 is an example of this kind of output.

i Region assignment
Each Marsden square is divided into ten regions as specified by input to the program. These regions may assume any configuration and are composed of the 1° subsquares. The subsquares within a region may be discontinuous. Observations are assigned by sub-square identifier. Output is from Area 1 (top) to Area 10 (bottom).

ii Wind sector assignment
Observations are also categorized by the direction from which the wind is blowing. The wind sectors are broken down into four quadrants. A fifth sector is defined for those winds identified as variable or calm. Table III gives the wind sector definitions. Wind sector 6 is a summary of all observations (all wind sectors) by region.

b. Variable definition. Table XI shows the variables and units which are summarized in the lists.

i The mean values are found using the following expression

$$\overline{X} = X_e + \frac{1}{n_{aw}} \sum_{i=1}^{n_{aw}} (X_i - X_e)$$

where n_{aw} is the number of valid observations for the area wind sector category (output variable 3).

X_e is an estimated mean value, unique for each variable.

ii The appropriate standard deviation terms are found with the following expression.

$$SD = \left(\frac{1}{n_{aw}} \Sigma \, (X_i - X_e)^2 - (\overline{X} - X_e)^2 \right)^{\frac{1}{2}}$$

iii The minimum and maximum values are simply the range of valid terms for a particular classification.

iv The transport ratio is defined as follows:

$$\text{ratio} = \frac{\overline{W}\,\overline{q_a}}{\overline{W\,q_a}}$$

where each mean is defined as in II.C.3.b.i above.

v Budyko terms

The Budyko heat flux terms are found using the relationships outlined in section II.B.2.h. All the general terms used in the heat flux expressions are the average values as determined in II.C.3.b.i above. Table VIII is used in the calculation of Q_0. The mid-latitude of the region being summarized was used in the interpolation for a given month.

vi The air density average output is as defined in section II.B.2.b. The calculation is a function of average values rather than being a calculated average density. Thus

$$\overline{\rho} = f(\overline{P}, \overline{\theta}_a, \overline{q}_a) \quad .$$

II.C.4 Annual summary

The final page contains selected parameters and the heat flux terms summarized over all the seasons. An example of this output is shown in Figure 6.

a. The first part of the annual summary is broken down by regions of the 10° squares over all wind sectors (sector 6 is the total of sectors 1 through 5). All general terms are then calculated by the following expression for each subregion.

$$\overline{X}_{annual} = \frac{\sum_{i=1}^{12} b_i \overline{X}_{a6_i}}{\sum_{i=1}^{12} b_i}$$

where $b_i = f(i)/30$

and $f(i)$ is the number of days in a given month.

Again, the purpose here is to give all seasons over the year equal weight. The number of observations is given only for reference.

The Budyko heat flux terms are found using the above assumptions.

b. The final line of the annual summary is the average over the entire 10° square. The method is similar to that described in section II.C.4.a, above, except that the seasonal average $\overline{X}$ replaces the regional average $\overline{X}_{a6}$.

II.D Storage and access to heat flux volumes

The heat flux summaries are stored as a separate volume for each 10° square. Each volume is identified by Marsden number, latitude-longitude range, and sea. The volumes are currently stored in Clark Laboratory, Room 358. A sign-out sheet is located near the volumes. Please list your name, telephone extension, volume taken, date out and date returned.

III. CLIMATOLOGICAL TIME SERIES

The climatological time series is a component of the WHOI/CASI archive which grew out of the heat flux study. The monthly averages of environmental parameters and fluxes have been organized into a time series for the years 1948 through 1972. The time series for each 10° square has been further processed to produce a statistical summary over a variety of seasonal time frames. The Atlantic Ocean climatology time series has been documented separately in WHOI-79-3 (see Reference 8). An initial analysis of the Atlantic Ocean climatology has been done by Bunker (9).

At the time of this writing, the processed climate files exist for only the Atlantic Ocean (see Figure 7). During the next phase of the climate study data for the Indian Ocean, Mediterranean, and Red Sea areas will be processed and incorporated into the archive.

III.A Storage and access to climatological data

The climatological component of the CASI archive is available in both printed and computer storage. The computerized data base has associated with it a variety of access and analysis software described briefly in section IV below.

III.A.1 Listed output

Both the time series of monthly averages and the seasonal statistics files are kept in volumes stored in Room 358 of Clark Laboratory. The monthly average files are divided into two volumes, one each for the North and South Atlantic. The seasonal statistics files are also separated, two volumes each for the North and South Atlantic. All 10° squares are identified by their Marsden reference number. A single separate volume contains both the time series averages and the seasonal statistics derived from the reports of ocean weather ships.

Because of the quantity of paper, there is only one copy of all volumes. Please try to leave all volumes in Room 358.

III.A.2 Computer storage of climatological data

The time series of monthly averages, as well as the seasonal statistics, have all been stored for computerized retrieval. The contents and formats of these files are documented in Reference 8 so are only discussed briefly below.

a. Magnetic tape storage

The tape series (CL) for the climate study is currently being stored in the IPC computer center tape vault. It is recommended that you copy the required file onto your own tape or disc for subsequent processing. The climatological files are stored on the magnetic tape in several different formats. An index of the climatological tapes is in Room 358 of the Clark Laboratory.

b. Disc storage

At the time of this writing, most of the time series and seasonal statistics files are being stored on a private disc pack. Each 10° square is stored as a separate file. The naming conventions and format are compatible with the Xerox labelled tape storage formats. For extensive studies of the climatological data, it probably will be far more efficient to work from this disc, if available. The user may otherwise create his own disc and index file.

IV COMPUTER SOFTWARE

The heat flux and climatology studies, as well as a variety of other projects, have initiated the development of numerous computer programs. These programs involve all components of the archive in both accessing and analysis functions. While it is not expected that the analysis programs will meet every researcher's requirements exactly, they may provide a base upon which modifications can be performed. Listed in the following sections are some of the software routines that have been developed or are currently available.

IV.A Programs using TDF-11 observations

The following programs were developed to read and analyze observations from the TDF-11 series. While the programs have been developed for specific applications or areas, they could be adapted to work on other parameters of 10° squares.

ASHFLA-M — A. Bunker IPC#7479 1974-5

This program, in several versions including ASHFLA, performs the heat flux analysis described in section II above. A separate version of the program exists for 10° squares in the southern hemisphere.

HEFLUVS — A. Bunker IPC#7353 1973

Computes the mean, standard deviation, minimum, maximum, and number of observations for various environmental parameters.

ASHVSUM — A. Bunker IPC#7541 1975

An extension of program HEFLUVS to process more parameters.

MARSAN 114 — Stommel/Fieux IPC#7342 1973

Provides a (line printer) graphical and statistical summary of sea surface temperature for Marsden 10° square 114.

AWASTAS — M. Fieux IPC#7467 1974

Graphical depiction of daily average wind velocity over a period of time.

ARABSEA — M. Fieux IPC#7437 1974

A printed summary of the air and sea temperatures and wind velocity in the Arabian Sea.

Air/Sea Wind Strees Analysis — P. Saunders IPC#7504 1975

Computes the time and geographic distribution of wind stress on the sea surface.

WDSETEMP — W. Deuser IPC#7573 1975

Computes the mean, standard deviation, and number of observations for Red Sea surface temperatures in 1° squares.

DISCOVER — Bunker/Chaffee IPC#U662 1976

Performs on-line entry of DISCOVERY data and conversion to TDF-11 format.

IV.B Programs using heat flux study data

The following programs were developed to process the time series of monthly averages generated by the ASHFLA programs. In general, they are used to establish the data base for the ongoing climatology study.

ASHCONVERT — R. Goldsmith IPC#U756 1977

Converts various ASHFLA formats to the Atlantic climatology (ACS) format.

POSWEIGHT — R. Goldsmith IPC#U756 1977

Computes a weighted center of observations for a 10° square.

ACSEDIT — A. Bunker IPC#U756 1977

Creates a continuous time series of monthly average values.

ACSTOBIN — R. Goldsmith IPC#U756 1977

Creates a binary format copy of the EBCDIC file created by program ACSEDIT.

IRUPDATE — A. Bunker IPC#U756 1978

Creates a new time series file of monthly averages, correcting the heat flux terms for anomalous high altitude water vapor.

IV.C Programs associated with the climatology study

The study of the climatology of the Atlantic Ocean produced software in three basic categories. These are 1) library of data access routines, 2) utility processing routines, and 3) general analysis routines.

IV.C.1 Routines to access climatological data

STARTDAT — R. Goldsmith IPC#U756 1977
Computes the number of months from some initial starting month.

ACSLABEL — R. Goldsmith IPC#U930 1979
Retrieves parameter, units, and season labels.

ACSFILEINFO — R. Goldsmith IPC#U756 1978
Retrieves file storage information from file index tables.

ACSDATAFILE — R. Goldsmith IPC#U756 1977
Provides access to the time series of monthly averages.

ACSSTATFILE — R. Goldsmith IPC#U756 1977
Provides access to the seasonal statistics files.

IV.C.2 Utility processing routines

ACSTREND — A. Bunker IPC#U756 1977
This program is used to produce both the climatological seasonal summary files and the volumes of printed summaries.

ACSLOOK — R. Goldsmith IPC#U930 1979
Allows an on-line user to extract data or statistical values.

PARLIST — A. Bunker IPC#U756 1978
Produces a parameter listing of data values from the monthly averages file.

ACSDIF A. Bunker IPC#U756 1978

Finds 10° squares with largest departures from local mean for selected parameters.

ACSSDORD A. Bunker IPC#U756 1978

Orders the 10° squares by the seasonal standard deviation for a selected parameter.

ACSPLOT A. Bunker IPC#U756 1978

Plots any selected parameter as a function of time for a 10° square data file.

ACSQPLOT R. Goldsmith IPC#U756 1978

Provides plotting of time series data from an intermediate format.

ACSTRAM A. Bunker IPC#U930 1979

Produces trend anomaly maps (line printer) for a selected parameter.

ACSMAP A. Bunker IPC#U756 1978

Produces a plot of data, statistics, or anomalies over the Atlantic Ocean. The data may be optionally output in a format suitable for entry into the contouring routine OPCONT.

IV.C.3 General analysis routines

ACSTIMSAN R. Goldsmith IPC#U756 1978

Selects and formats monthly averages of parameters for entry into the time series analysis (TIMSAN).

ACSBIGEIG A. Bunker IPC#U930 1979

Computes the covariance matrix and eigenvalues for up to one hundred 10° squares.

ACSEIGAN A. Bunker IPC#U930 1979

Analyzes the eigenvectors produced by ACSBIGEIG, and ranks the 10° squares by contribution.

ACSEIGAMP R. Goldsmith IPC#U930 1979

Computes the eigenvector amplitude function.

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TABLE I.

Parameters most often available from TDF-11 of the Surface Marine observations:

Field	Character position	Parameter
1	01-03	Card deck identifier
2	04-06	10° square Marsden reference number
3	07-08	1° subsquare Marsden reference number
4	09	quadrant
5	10-12	latitude
6	13-16	longitude
7	17-20	year
8	21-22	month
9	23-24	day
10	25-26	hour - GMT
11	27-29	wind direction
12	30-33	wind speed
13	34-36	visibility
14	37-38	present weather code
15	39	past weather code
16	40-44	sea level pressure
17	45-48	air temperature
18	49-51	wet bulb temperature
19	52-54	dew point temperature
20	55-57	sea surface temperature
21	58-60	air-sea temperature difference
22	61	total cloud amount
22	62	lower cloud amount
22	63	type of low cloud code
22	64	cloud height code
22	65	cloud height
22	66	type of middle cloud code
22	67	type of high cloud code
23	68-69	direction of waves
24	70	period of waves
25	71-72	height of waves

TABLE II.

TDF-11 data requirements for the heat flux study.

Variable	Units
Marsden 10° square	
Marsden 1° subsquare	
Latitude, ϕ	degrees
Year	
Month, m	
Day, d	
Wind direction code indicator, D_1	
Wind direction code, D_2	
Wind speed, W	knots
Present Weather Code, W_c	
Sea level pressure, P	millibars
Air temperature, T_a	°C
Dew point temperature, T_d	°C
Sea surface temperature, T_s	°C
Air-sea temperature difference, T_{as}	°C
Total cloud amount, N_T	oktas
Lower or middle cloud amount, N_L	oktas

TABLE III.

Direction from which wind is blowing, $f(D_1,D_2)$, as a function of D_1, the wind direction code indicator, and D_2, the wind direction code.

WIND SECTOR CLASSIFICATION

CODE	MID	SECT	MID	SECT	MID	SECT	MID	SECT
			SCALE CODES 0		1		2	
1	9.5	4	11.0	4	.0	4	.0	4
2	19.5	1	22.5	1	22.5	1	23.0	1
3	29.5	1	34.0	1	.0	1	.0	1
4	39.5	1	45.0	1	.0	1	45.5	1
5	49.5	1	56.0	1	45.0	1	.0	1
6	59.5	1	67.5	1	.0	1	68.0	1
7	69.5	1	79.0	1	67.5	1	.0	1
8	79.5	1	90.0	1	.0	1	90.5	1
9	89.5	1	101.0	1	90.0	1	.0	1
10	99.5	1	112.5	2	.0	1	113.0	2
11	109.5	2	124.0	2	112.5	2	.0	2
12	119.5	2	135.0	2	.0	2	135.5	2
13	129.5	2	146.0	2	.0	2	.0	2
14	139.5	2	157.5	2	135.0	2	158.0	2
15	149.5	2	169.0	2	.0	2	.0	2
16	159.5	2	180.0	2	157.5	2	180.5	2
17	169.5	2	191.0	2	.0	2	.0	2
18	179.5	2	202.5	3	180.0	2	203.0	3
19	189.5	2	214.0	3	.0	2	.0	3
20	199.5	3	225.0	3	202.5	3	225.5	3
21	209.5	3	236.0	3	.0	3	.0	3
22	219.5	3	247.5	3	.0	3	248.0	3
23	229.5	3	259.0	3	225.0	3	.0	3
24	239.5	3	270.0	3	.0	3	270.5	3
25	249.5	3	281.0	3	247.5	3	.0	3
26	259.5	3	292.5	4	.0	3	293.0	4
27	269.5	3	304.0	4	270.0	3	.0	4
28	279.5	3	315.0	4	.0	3	315.5	4
29	289.5	4	326.0	4	292.5	4	.0	4
30	299.5	4	337.5	4	.0	4	338.0	4
31	309.5	4	349.0	4	.0	4	.0	4
32	319.5	4	.0	4	315.0	4	.5	4
33	329.5	4	.0	5	.0	4	.0	5
34	339.5	4	.0	5	337.5	4	.0	5
35	349.5	4	.0	5	.0	4	.0	5
36	359.5	4	.0	5	360.0	4	.0	5

TABLE IV.

Exchange Coefficient $C_E = f(W, T_{as})$

TABLE OF EXCHANGE COEFFICIENTS (X 1000)

WIND SPEED (M/SEC)	AIR-SEA TEMPERATURE (C) >5.0	>1.0	>0.2	>-.2	>-1.	>-5.	<-5.0
= 0	.00	.00	.00	.00	.00	.00	.00
<= 3	.07	.30	.72	1.32	1.65	2.05	2.52
<= 6	.22	.67	1.12	1.34	1.45	1.68	2.01
<= 9	.69	1.17	1.36	1.44	1.46	1.58	1.79
<= 12	1.06	1.36	1.48	1.53	1.58	1.65	1.79
<= 15	1.39	1.58	1.61	1.64	1.68	1.74	1.84
<= 20	1.59	1.68	1.75	1.80	1.82	1.86	1.94
<= 25	1.74	1.79	1.83	1.86	1.88	1.86	1.93
<= 30	1.81	1.84	1.85	1.86	1.87	1.88	1.90
> 30	1.86	1.86	1.86	1.86	1.86	1.86	1.86

TABLE Va.

Albedo of the sea surface, $f(m,\phi)$, as a function of m, the month, and ϕ, the latitude. (From Reference 5.)

For the Northern Hemisphere:

ALBEDO TABLE

LAT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
90	.00	.00	.00	.20	.15	.12	.10	.10	.18	.00	.00	.00
80	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
70	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.10
60	.10	.10	.08	.08	.07	.07	.07	.07	.08	.08	.10	.11
50	.11	.10	.08	.07	.06	.06	.06	.07	.07	.08	.11	.12
40	.10	.09	.07	.07	.06	.06	.06	.06	.07	.08	.10	.11
30	.09	.07	.06	.06	.06	.06	.06	.06	.06	.07	.08	.09
20	.07	.06	.06	.06	.06	.06	.06	.06	.06	.06	.07	.07
10	.07	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
0	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06

TABLE Vb.

Albedo of the sea surface, $f(m,\phi)$, as a function of m, the month, and ϕ, the latitude. (From Reference 5.)

For the Southern Hemisphere:

ALBEDO TABLE

LAT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
10	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06
20	.06	.06	.06	.06	.07	.07	.07	.06	.06	.06	.06	.06
30	.06	.06	.07	.08	.09	.09	.09	.08	.07	.07	.06	.06
40	.06	.07	.08	.09	.10	.10	.10	.09	.08	.07	.06	.06
50	.06	.07	.08	.09	.11	.11	.11	.09	.08	.07	.06	.06
60	.07	.08	.09	.10	.11	.11	.11	.10	.09	.08	.07	.07
70	.55	.55	.55	.80	.80	.80	.80	.80	.80	.55	.55	.55
80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80

TABLE VI.

C - long wave radiation cloud cover coefficient from Budyko (see Reference 7).

Latitude	C
0	.48
10	.52
20	.59
30	.63
40	.68
50	.72
60	.76
70	.80
80	.84
90	.88

TABLE VII.

Drag coefficient $C_D = f(W, T_{as})$

TABLE OF DRAG COEFFICIENTS (X 1000)

WIND SPEED (M/SEC)	AIR-SEA TEMPERATURE (C) >5.0	>1.0	>0.2	>-.2	>-1.	>-5.	<-5.0
= 0	.00	.00	.00	.00	.00	.00	.00
<= 5	.06	.60	.98	1.20	1.32	1.56	1.80
<= 10	.77	1.30	1.43	1.54	1.60	1.78	1.86
<= 15	1.47	1.72	1.80	1.87	1.90	2.00	2.10
<= 20	1.95	2.04	2.10	2.16	2.22	2.25	2.32
<= 25	2.26	2.30	2.35	2.40	2.42	2.44	2.48
<= 30	2.52	2.54	2.57	2.60	2.62	2.63	2.64
<= 35	2.78	2.79	2.80	2.80	2.80	2.80	2.80
<= 40	3.00	3.00	3.00	3.00	3.00	3.00	3.00
<= 50	3.20	3.20	3.20	3.20	3.20	3.20	3.20
> 50	3.40	3.40	3.40	3.40	3.40	3.40	3.40

TABLE VIIIa

Solar radiation received at the bottom of the atmosphere under cloudless conditions: $Q_0 = f(m,\phi)$ where m is the month and ϕ is the latitude. Converted to watts•meter^{-2} from Reference 7.

For the Northern Hemisphere:

SOLAR RADIATION TABLE
BOTTOM OF ATMOSPHERE - (WATTS/METER**2)

LAT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
90	.0	.0	1.6	159.4	349.1	414.4	379.4	205.6	38.3	.0	.0	.
80	.0	.0	38.3	172.2	341.1	401.7	366.6	213.6	68.5	8.0	.0	.
70	.0	25.5	95.6	208.8	326.8	376.2	337.9	232.7	119.6	43.0	8.0	.
60	28.7	68.5	157.8	255.4	331.6	365.0	341.1	266.2	180.1	97.2	41.4	17.
50	76.5	130.7	212.0	294.9	353.9	377.8	360.2	304.5	229.5	154.6	92.5	62.
40	140.3	194.5	261.4	323.6	366.6	382.6	373.0	333.1	271.0	210.4	154.6	122.
30	199.3	247.1	296.5	341.1	366.6	379.4	373.0	347.5	304.5	255.6	208.8	183.
20	247.1	285.3	322.0	344.3	358.7	363.4	360.2	344.3	325.2	294.9	256.6	234.
10	288.6	315.6	336.3	337.9	337.9	334.7	336.3	328.4	337.9	320.4	294.9	279.
0	322.0	333.1	342.7	325.2	307.6	299.7	304.5	307.6	337.9	337.9	325.2	306.

TABLE VIIIb

Solar radiation received at the bottom of the atmosphere under cloudless conditions: $Q_0 = f(m,\phi)$ where m is the month and ϕ is the latitude. Converted to watts•meter^{-2} from Reference 7.

For the Southern Hemisphere:

SOLAR RADIATION TABLE
BOTTOM OF ATMOSPHERE - (WATTS/METER**2)

LAT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	322.0	333.1	342.7	325.2	307.6	299.7	304.5	307.6	337.9	337.9	325.2	306.0
10	350.7	347.5	336.3	306.0	282.1	259.8	259.8	275.8	325.2	341.1	347.5	350.7
20	369.8	350.7	318.8	274.2	234.3	213.6	220.0	237.5	301.3	334.7	360.2	376.2
30	381.0	347.5	296.5	237.5	189.7	169.0	176.9	192.9	271.0	320.4	366.6	392.1
40	382.6	328.4	261.4	194.5	138.7	116.4	129.1	143.5	227.9	298.1	363.4	401.7
50	376.2	301.3	220.0	146.5	86.1	60.6	73.3	87.7	191.3	264.6	347.5	398.5
60	360.2	264.6	174.4	89.3	38.3	15.9	25.5	36.7	135.5	224.8	334.7	388.9
70	360.2	226.3	116.4	35.1	1.6	.0	.0	.0	79.7	181.7	334.7	396.9
80	382.6	204.0	68.5	.0	.0	.0	.0	.0	33.5	154.6	349.1	414.4
90	396.7	196.1	27.1	.0	.0	.0	.0	.0	.0	143.5	360.2	430.4

TABLE IX.

A_c - Incoming solar radiation cloud cover coefficient from Budyko (see Reference 7).

Latitude	A_c cloud cover
0	.38
5	.40
10	.40
15	.39
20	.37
25	.35
30	.36
35	.38
40	.38
45	.38
50	.40
55	.41
60	.36
65	.25
70	.18
75	.16
80	.15
85	.00
90	.00

TABLE X.

Variable key for monthly and yearly averages.

VARIABLE KEY FOR MONTHLY AND YEARLY AVERAGES

FIELD NO.	IDENTIFIER	DESCRIPTION	UNITS
1	MS	= MARSDEN SQUARE NUMBER	
2	YEAR	= YEAR	
3	MONTH	= MONTH	
	VAR	= ANNUAL % VARIATION OF MONTHLY OBS	
4	OBS	= NUMBER OF OBSERVATIONS	
5	TA	= AVERAGE AIR TEMPERATURE	(C)
6	MXR	= AVERAGE MIXING RATIO	(G/KG)
7	TS	= AVERAGE SEA SURFACE TEMPERATURE	(C)
8	TASD	= AVERAGE AIR-SEA TEMPERATURE DIFFERENCE	(C)
9	N	= AVERAGE TOTAL CLOUD COVER	(OKTAS)
10	W	= AVERAGE WIND SPEED	(M/SEC)
11	U	= AVERAGE X WIND VELOCITY	(M/SEC)
12	V	= AVERAGE Y WIND VELOCITY	(M/SEC)
13	MD	= MEAN DIRECTION OF RESULTANT WIND	(FROM 0 NORTH)
14	RRAT	= RATIO OF RAIN TO TOTAL OBS	
15	P	= AVERAGE PRESSURE	(PASCALS)/100
16	SIRAT	= RATIO OF SEA ICE OBS TO TOTAL OBS	
		USING BUDYKO METHOD	
17	G(1-ALB)	= AVERAGE RADIATION AT SURFACE	(WATTS/METER**2)
18	IR	= AVERAGE EFFECTIVE INFRA-RED	(WATTS/METER**2)
19	R	= AVERAGE RADIATIONAL EXCHANGE	(WATTS/METER**2)
20	LE	= AVERAGE LATENT HEAT FLUX	(WATTS/METER**2)
21	SE	= AVERAGE SENSIBLE HEAT FLUX	(WATTS/METER**2)
22	A(B)	= AVERAGE NET HEAT GAIN BY OCEAN	(WATTS/METER**2)
		USING OBSERVATIONS	
23	LE	= AVERAGE LATENT HEAT FLUX	(WATTS/METER**2)
24	SE	= AVERAGE SENSIBLE HEAT FLUX	(WATTS/METER**2)
25	A(B,I)	= AVERAGE NET HEAT GAIN BY OCEAN	(WATTS/METER**2)
26	TAUX	= AVERAGE STRESS IN X DIRECTION	(PASCALS)
27	TAUY	= AVERAGE STRESS IN Y DIRECTION	(PASCALS)

TABLE XI.

Variable key for seasonal summaries by region and sector

VARIABLE KEY FOR SEASONAL SUMMARIES BY AREA AND SECTOR

FIELD NO.	IDENTIFIER	DESCRIPTION	UNITS
1	MS	- MARSDEN SQUARE	
2	MONTH	- MONTH	
3	OBS	- NUMBER OF OBSERVATIONS	
4	TA	- AVERAGE AIR TEMPERATURE	(C)
5	SD	- STANDARD DEVIATION OF AIR TEMPERATURE	(C)
6	MIN	- MINIMUM AIR TEMPERATURE	(C)
7	MAX	- MAXIMUM AIR TEMPERATURE	(C)
8	TD	- AVERAGE DEW POINT	(C)
9	SD	- STANDARD DEVIATION OF DEW POINT	(C)
10	MIN	- MINIMUM DEW POINT	(C)
11	MAX	- MAXIMUM DEW POINT	(C)
12	TS	- AVERAGE SEA TEMPERATURE	(C)
13	SD	- STANDARD DEVIATION OF SEA TEMPERATURE	(C)
14	MIN	- MINIMUM SEA TEMPERATURE	(C)
15	MAX	- MAXIMUM SEA TEMPERATURE	(C)
16	TASD	- AIR-SEA TEMPERATURE	(C)
17	SD	- STANDARD DEVIATION OF AIR-SEA TEMPERATURE	(C)
18	MIN	- MINIMUM AIR-SEA TEMPERATURE	(C)
19	MAX	- MAXIMUM AIR-SEA TEMPERATURE	(C)
20	NT	- AVERAGE TOTAL CLOUD COVER	(OKTAS)
21	NL	- AVERAGE LOWER CLOUD COVER	(OKTAS)
22	MXR	- AVERAGE MIXING RATIO	(G/KG)
23	MXRS	- AVERAGE MIXING RATIO OVER SEA	(G/KG)
24	PRES	- AVERAGE PRESSURE	(PASCALS)/100
25	SD	- STANDARD DEVIATION OF PRESSURE	(PASCALS)/100
26	MIN	- MINIMUM PRESSURE	(PASCALS)/100
27	WS	- AVERAGE WIND SPEED	(M/SEC)
28	SD	- STANDARD DEVIATION OF WIND SPEED	(M/SEC)
29	MAX	- MAXIMUM WIND SPEED	(M/SEC)
30	U	- AVERAGE X WIND COMPONENT	(CM/SEC)
31	SD	- STANDARD DEVIATION OF X WIND	(CM/SEC)
32	V	- AVERAGE Y WIND COMPONENT	(CM/SEC)
33	SD	- STANDARD DEVIATION OF Y WIND	(CM/SEC)
34	MD	- MEAN DIRECTION OF THE WIND	(DEGREES FROM 0 NORTH)
35	R/NR	- RATIO OF RAIN TO TOTAL OBS	
36		-	
		USING BUDYKO METHOD	
37	G(1-ALB)	- AVERAGE RADIATION AT SURFACE	(WATTS/METER**2)
38	IR	- AVERAGE EFFECTIVE INFRA-RED	(WATTS/METER**2)
39	R	- AVERAGE RADIATIONAL EXCHANGE	(WATTS/METER**2)
40	LE	- AVERAGE LATENT HEAT FLUX	(WATTS/METER**2)
41	SE	- AVERAGE SENSIBLE HEAT FLUX	(WATTS/METER**2)
42	A(B)	- AVERAGE NET HEAT GAIN BY OCEAN	(WATTS/METER**2)
		USING OBSERVATIONS	
43	LE	- AVERAGE LATENT HEAT FLUX	(WATTS/METER**2)
44	SE	- AVERAGE SENSIBLE HEAT FLUX	(WATTS/METER**2)
45	A(B,I)	- AVERAGE NET HEAT GAIN BY OCEAN	(WATTS/METER**2)
46	TAUX	- AVERAGE STRESS IN X DIRECTION	(PASCALS)
47	TAUY	- AVERAGE STRESS IN Y DIRECTION	(PASCALS)
48	CE	- EXCHANGE COEFFICIENT (*1000)	
49	W*G/WG	- TRANSPORT RATIO	
50	RHO	- AIR DENSITY F(4,22,24)	(KG/M**3)
51	A(B)*AREA	- TOTAL HEAT GAIN BY OCEAN	(WATTS)/10**12
52	A(B,I)*AREA	- TOTAL HEAT GAIN BY OCEAN	(WATTS)/10**12

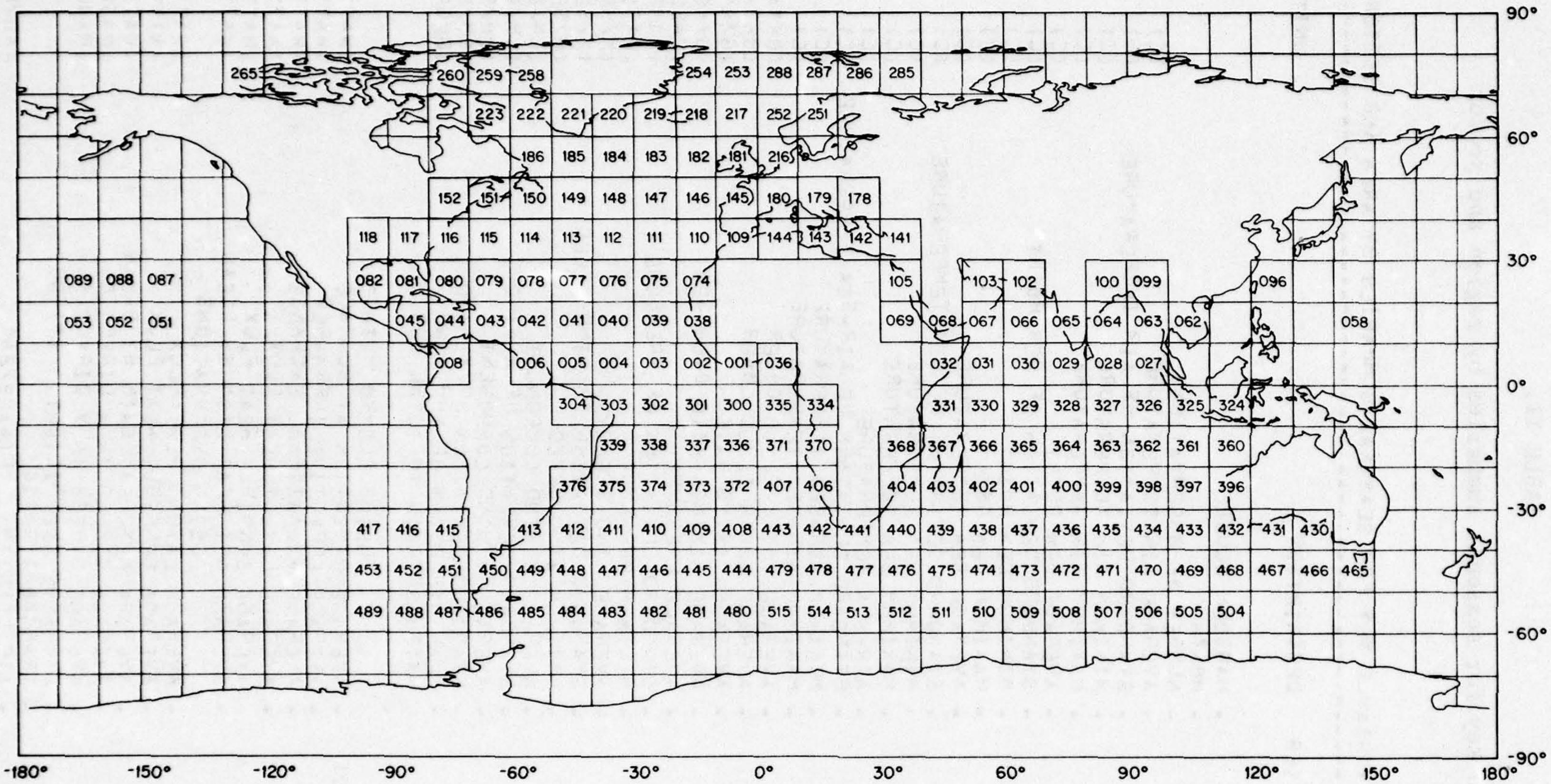

Figure 1. Area coverage of TDF-11 at W.H.O.I.

Figure 2. Example of WHOI/TDF-11 Index

* INDICATES A 7T TAPE CLRK 358

MS	MN/ YR	TO MN/ YR	TAPE	LAT	LONG	# OBS	OWNER	LOCATION
							BUNKER	CLRK 358
001	06 1855	04 1973	BAA1	5N	5W	96250	BUNKER	CLRK 358
002	12 1906	12 1924	BAA2	5N	15W	110000	BUNKER	CLRK 358
002	12 1924	12 1972	BAA3	5N	15W	106890	BUNKER	CLRK 358
003	01 1863	04 1923	BAA4	5N	25W	110000	BUNKER	CLRK 358
003	04 1923	12 1972	BAA5	5N	25W	86570	BUNKER	CLRK 358
004	03 1923	12 1972	BAA6	5N	35W	52430	BUNKER	CLRK 358
005	11 1941	04 1967	BAA6	5N	35W	57570	BUNKER	CLRK 358
005	04 1967	12 1972	BAA7	5N	45W	21650	BUNKER	CLRK 358
006	08 1941	12 1972	BAA7	5N	55W	48500	BUNKER	CLRK 358
008	01 1942	07 1968	BAA7	5N	75W	52000	BUNKER	CLRK 358
008	07 1968	12 1972	BAA8	5N	75W	19000	BUNKER	CLRK 358
027	02 1921		BAJ3	5N	95E		BUNKER	CLRK 358
027			BAJ4	5N	95E		BUNKER	CLRK 358
027		12 1972	BAJ5	5N	95E		BUNKER	CLRK 358
028	02 1914	09 1934	BAJ6	5N	85E	110000	BUNKER	CLRK 358
028	09 1934	01 1966	BA99	5N	85E	110000	BUNKER	CLRK 358
028	09 1934	12 1966	BAJ7	5N	85E		BUNKER	CLRK 358
028	12 1966	12 1974	BAJ8	5N	85E		BUNKER	CLRK 358
029	11 1855	04 1921	FMA9	5N	75E	100000	STOMMEL	PARIS FR
029	04 1921	02 1935	FMB9	5N	75E	100000	STOMMEL	PARIS FR
029	02 1935	03 1966	FMC9	5N	75E	100000	STOMMEL	PARIS FR
029	03 1966	04 1973	FMD9	5N	75E	20500	STOMMEL	PARIS FR
030	11 1856	01 1924	FMD9	5N	65E	69500	STOMMEL	PARIS FR
030	01 1924	09 1954	FMA0	5N	65E	100000	STOMMEL	PARIS FR
030	09 1954	03 1973	FMB0	5N	65E	25400	STOMMEL	PARIS FR
031	01 1857	12 1972	FMA1	5N	55E	95200	STOMMEL	PARIS FR
032	01 1857	05 1926	FMA1	5N	45E	5000	STOMMEL	PARIS FR
032	06 1926	12 1972	FMB2	5N	45E	15600	STOMMEL	PARIS FR
036	01 1941	12 1972	BAA8	5N	5E	19170	BUNKER	CLRK 358
038	09 1931	06 1968	BAA9	15N	15W	120000	BUNKER	CLRK 358
038	06 1968	12 1972	BAB1	15N	15W	53000	BUNKER	CLRK 358
039	04 1930	12 1972	BAB2	15N	25W	120000	BUNKER	CLRK 358
040	03 1859	12 1972	BAB3	15N	35W	83300	BUNKER	CLRK 358
041	07 1937	12 1972	BAB4	15N	45W	30900	BUNKER	CLRK 358
042		12 1963	BAB4	15N	55W	90570	BUNKER	CLRK 358
042	12 1963	12 1972	BAB5	15N	55W	89100	BUNKER	CLRK 358
043	03 1934	09 1956	BAB6	15N	65W	120000	BUNKER	CLRK 358
043	09 1956	04 1965	BAB7	15N	65W	120000	BUNKER	CLRK 358
043	04 1965	07 1972	BAB8	15N	65W	120000	BUNKER	CLRK 358
043	07 1972	12 1972	BAB9	15N	65W	6600	BUNKER	CLRK 358
044	01 1941	08 1949	BAB9	15N	75W	113370	BUNKER	CLRK 358
044	08 1949	09 1960	BAC1	15N	75W	123000	BUNKER	CLRK 358
044	09 1960	10 1968	BAC2	15N	75W	123000	BUNKER	CLRK 358
044	10 1968	12 1972	BAC3	15N	75W	56600	BUNKER	CLRK 358
045	01 1942	06 1955	BAC3	15N	85W	76600	BUNKER	CLRK 358
045	06 1955	01 1972	BAC4	15N	85W	123000	BUNKER	CLRK 358
045	01 1972	12 1972	BAC5	15N	85W	1800	BUNKER	CLRK 358
051	06 1857	04 1959	RC20	15N	145W	74400	MILLER	COMP CTR
051	04 1959		RC21	15N	145W	12000	MILLER	COMP CTR
052			RC21	15N	155W	8000	MILLER	COMP CTR

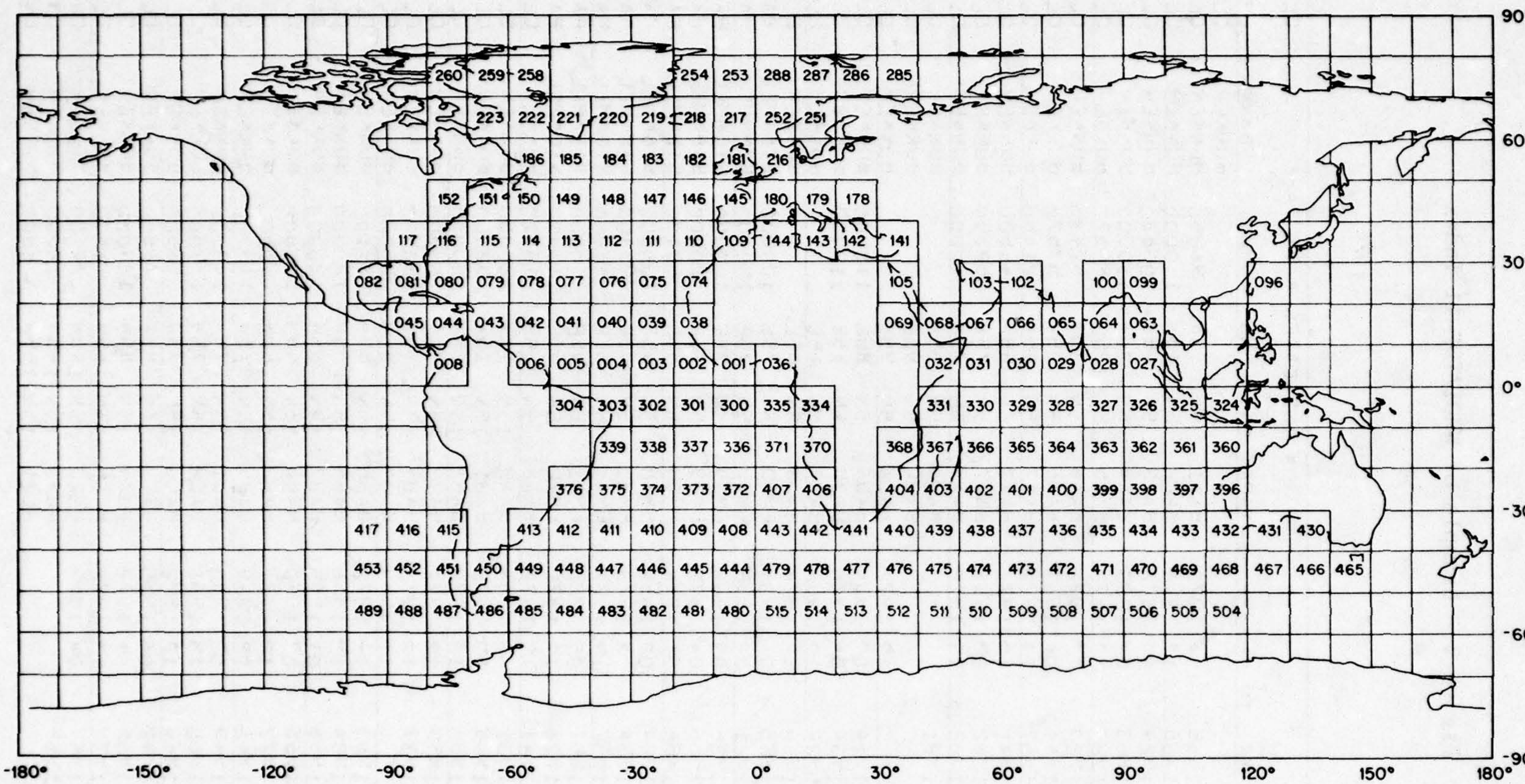

Figure 3. Spatial coverage of the heat flux (ASHFLA) files at W.H.O.I.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
150	1951	10	671	14.7	9	16.7	-2.0	5.6	9	2	-1	304	.16	1019	.00	90.9	38.3	52.6	197.5	45.3	-190.2	160.1	44.6	-152.1	.07	-.05
150	1951	11	577	11.5	7	13.6	-2.1	6.0	9	2	0	256	.18	1018	.00	54.7	36.0	18.7	156.1	49.3	-186.8	141.6	51.2	-174.2	.05	-.00
150	1951	12	574	7.8	6	11.5	-3.8	6.6	11	3	-1	292	.28	1013	.00	34.9	32.5	2.5	223.5	105.2	-326.3	189.1	92.3	-279.0	.14	-.02
150	1951	174	1822	11.3	7	13.9	-2.6	6.1	9	2	-1	285	.20	1017	.00	60.2	35.6	24.6	192.8	66.8	-234.9	163.9	62.8	-202.0	.09	-.02

Figure 4. Example of monthly and yearly averages summarized in the ASHFLA volumes.

Figure 5. Example of seasonal region-wind sector summary produced in the ASHFLA study.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
		WIND SECTOR 1																										
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
		WIND SECTOR 2																										
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	2	12.5	.3	12	13	7.8	.3	8	8	12.8	1.6	11	14	-.3	1.35	-1	1	8.0	4.0	6.5	9.0	1018	.4	1017	10	1	10
150	10	1	16.7	.0	17	17	14.9	.0	15	15	13.3	.0	13	13	3.4	.00	3	3	8.0	8.0	10.6	9.4	1008	.0	1008	11	0	11
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
		WIND SECTOR 3																										
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	1	7.8	.0	8	8	4.2	.0	4	4	9.4	.0	9	9	-1.6	.00	-1	-1	6.0	5.0	5.0	7.1	1025	.0	1025	9	0	9
150	10	2	13.1	.3	13	13	13.1	.3	13	13	8.9	.0	9	9	4.2	.25	4	4	8.0	8.0	9.4	7.0	1003	.4	1003	11	0	11
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	1	12.8	.0	13	13	9.6	.0	10	10	12.2	.0	12	12	.6	.00	1	1	6.0	.0	7.3	8.5	1027	.0	1027	2	0	2
150	10	1	13.3	.0	13	13	9.4	.0	9	9	12.5	.0	13	13	.5	.00	1	1	6.0	.0	7.2	8.9	1029	.0	1029	2	0	2
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
		WIND SECTOR 4																										
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	1	11.7	.0	12	12	8.6	.0	9	9	10.6	.0	11	11	1.1	.00	1	1	4.0	.0	6.9	7.8	1013	.0	1013	10	0	10
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	1	11.1	.0	11	11	5.0	.0	9	9	14.4	.0	14	14	-3.3	.00	-2	-2	8.0	5.0	7.1	5.5	1023	.0	1023	9	0	9
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
		WIND SECTOR 5																										
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
		WIND SECTOR 6																										
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	1	7.8	.0	8	8	4.2	.0	4	4	9.4	.0	9	9	-1.6	.00	-1	-1	6.0	5.0	5.0	7.1	1025	.0	1025	9	0	9
150	10	5	12.6	.6	12	13	10.1	2.5	8	13	10.8	2.0	9	14	1.8	2.18	-1	4	7.2	4.3	7.8	7.5	1011	6.5	1003	11	1	11
150	10	1	16.7	.0	17	17	14.9	.0	15	15	13.3	.0	13	13	3.4	.00	3	3	8.0	8.0	10.6	9.4	1008	.0	1008	11	0	11
150	10	2	12.0	.5	11	13	9.3	.3	9	10	13.3	1.1	12	14	-1.3	1.95	-2	1	7.0	2.5	7.2	9.2	1025	2.3	1023	5	4	9
150	10	1	13.3	.0	13	13	9.4	.0	9	9	12.6	.0	13	13	.5	.00	1	1	6.0	.0	7.2	8.9	1029	.0	1029	2	0	2
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0
150	10	0	.0	.0	0	0	.0	.0	0	0	.0	.0	0	0	.0	.00	0	0	.0	.0	.0	.0	0	.0	0	0	0	0

AREAS 1-10 OVER ALL WIND SECTORS
30 DAY AVERAGE OVER ALL MONTHS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
150		0	.0				.0				.0				.0				.0	.0	.0	.0	0			0		
150		0	.0				.0				.0				.0				.0	.0	.0	.0	0			0		
150		1	7.8				4.2				9.4				-1.6				6.0	5.0	5.0	7.1	1025			9		
150		5	12.6				10.1				10.8				1.8				7.2	4.8	7.8	7.9	1011			11		
150		1	16.7				14.9				13.3				3.4				8.0	8.0	10.6	9.4	1008			11		
150		2	12.0				9.3				13.3				-1.3				7.0	2.5	7.2	9.2	1025			5		
150		1	13.3				9.4				12.8				.5				6.0	.0	7.2	8.9	1029			2		
150		1	17.2				17.2				13.9				3.3				3.0	2.0	12.2	9.6	1018			10		
150		4	21.1				17.8				22.9				-1.8				3.8	1.8	12.8	17.1	1024			7		
150		5	21.8				18.5				21.2				.6				4.8	3.2	13.3	15.5	1021			10		

30 DAY AVERAGE OVER ENTIRE MARSDEN SQUARE 150

150	20	16.7	13.8	16.3	.4	5.6	3.4	10.3	11.9	1019	9	

30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0		0		270	.00		.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.00	.00	.00	.00	.00	.00
0		0		270	.00		.0	.0	.0	.0	.0	.0	.0	.0	.0	.00	.00	.00	.00	.00	.00	.00
875		0		270	.00		74.7	36.1	38.6	117.9	37.4	-116.7	88.7	28.2	-78.3	.17	-.00	1.58	1.00	1.27	-1.35	-.90
395		552		216	.00		53.9	26.8	27.1	11.6	-48.4	63.8	9.4	-31.7	49.4	.10	.12	1.42	.99	1.23	.74	.57
-433		1046		158	1.00		38.2	20.2	18.1	-88.4	-97.8	204.3	-57.3	-63.3	138.7	-.10	.25	1.36	1.00	1.20	2.36	1.60
399		-298		307	.00		62.5	29.3	33.2	71.5	19.2	-57.4	69.7	31.2	-67.7	.07	-.07	1.18	1.01	1.25	-.66	-.78
154		0		270	.00		85.3	36.4	48.8	16.6	-2.0	34.2	5.7	-.7	43.8	.00	.00	.72	1.00	1.25	.04	.05
327		922		200	.00		97.8	47.4	50.5	-157.0	-82.6	290.0	-101.6	-53.5	205.6	.05	.14	1.36	1.00	1.21	6.36	4.51
240		584		202	.00		94.4	45.2	49.2	173.1	29.6	-153.4	98.4	4.8	-54.0	.04	.12	1.78	.96	1.20	-1.77	-.62
261		898		196	.00		84.6	38.3	46.3	136.2	-14.1	-75.8	116.5	-.9	-69.3	.06	.20	1.46	1.00	1.20	-.88	-.80

30 DAY AVERAGE OVER ENTIRE MARSDEN SQUARE 150

299	544	209	.05	69.7	35.1	34.6	87.3	-8.5	-44.1	54.4	-8.6	-11.1	.06	.12	1.44	.98	1.22	4.84	3.62

Figure 6. Example of annual and total summary of parameters and fluxes in the ASHFLA study.

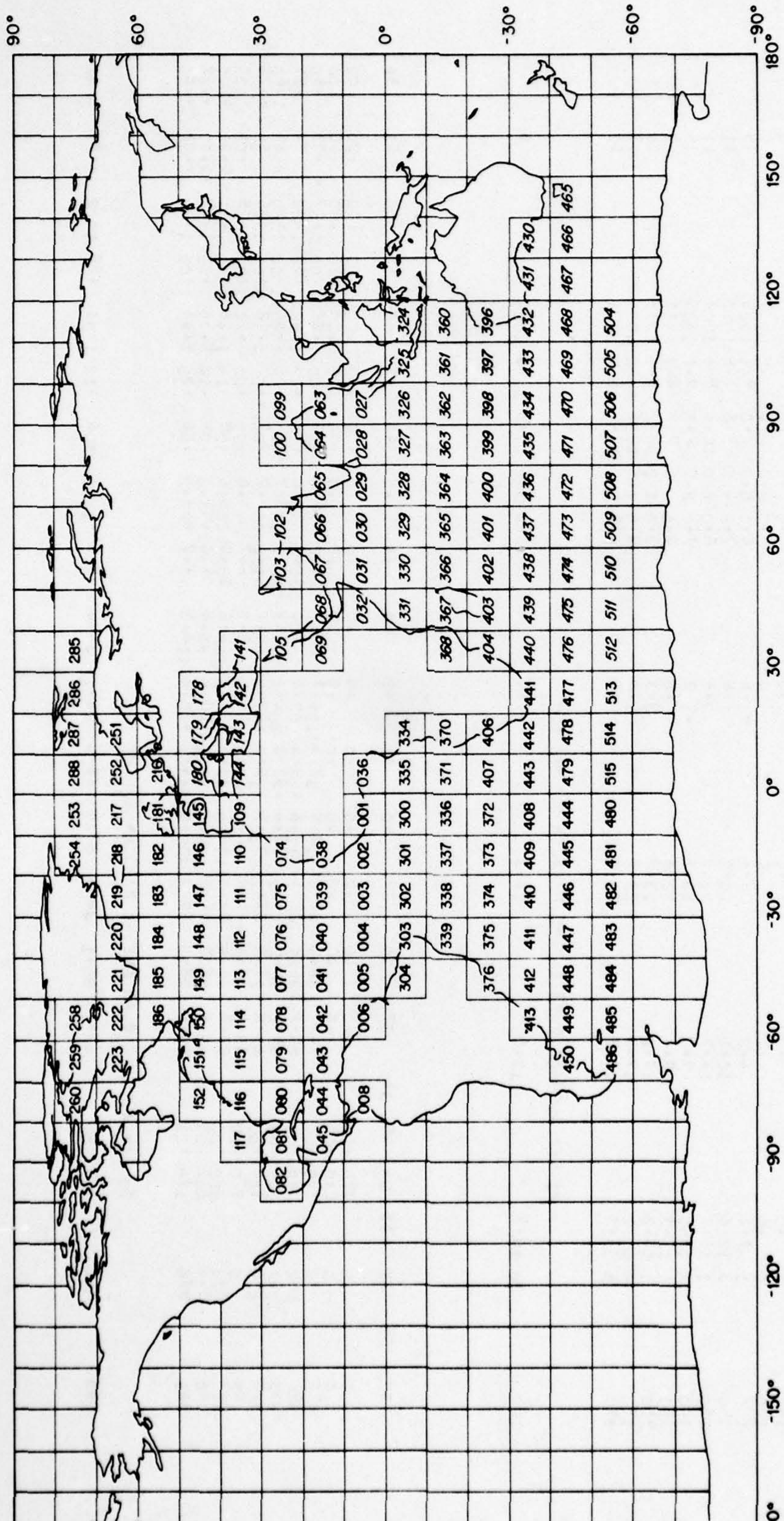

Figure 7. Climate areas processed.

APPENDIX A - National Climatic Center surface marine observations TDF-11 documentation.

INTRODUCTION

SOURCE

Tape Data Family - 11 was derived from a variety of punched card decks. Observations were obtained from Ship Logs, Ship Weather Reporting Forms, published Ship Observations, Automatic Observing Bouys, Teletype Reports, and on cards purchased from several foreign Meteorological Services.

The quality of instruments ranges from those found aboard a 19th century Whaling Ship to the most sophisticated electronic equipment used on today's Ocean Weather Ships. Observer qualifications vary from Deck Hand to trained Meteorologist.

From this conglomeration, an effort was made to bring to the researcher of oceanic weather patterns and sea conditions, a common observational format, designed for use with modern electronic data processing equipment. The International Marine punched card (Deck 128), established in 1963, was used as the basic input format to Tape Data Family - 11. Some modifications were made so that previously recorded observations could become an integral part of this Family.

QUALITY CONTROL AND CODE CONVERSIONS

The starting point for programming was the individual card deck. No attempt was made to "second guess" conversion or coding procedures employed in punching each of the various decks. This did lead to instances of double conversions. ie: Elements converted from the 1929 to the 1942 codes for punching, were then converted to the current codes for inclusion in the tape.

All conversion procedures used were devised or reviewed by professional meteorologists. Occasionally it was necessary to resort to subjective conversions based on observational experience as well as knowledge of instruments and observing techniques.

In cases where it was felt that elements were acceptable for conversion without significant loss of resolution, the new values were placed in the common portion of the observation. Elements or meteorological phenomena which did not lend themselves to conversion were retained in the supplemental portion of the observation.

During the taping, additional quality control checks were made. These checks flagged or rejected observations that did not meet specified conditions or limits. Extreme temperatures were established for each Marsden Square and individual observations were compared against these limits. Pressures were also checked against a set of extreme values. Ship positions had to be in ocean, sea, or lake areas. Wind directions, visibility, weather, sea conditions etc. had to be valid punches as defined by each card deck.

USE OF THE MANUAL

This manual was designed so that recourse to additional reference material should be unnecessary. Occasionally, however, the researcher may wish to obtain a copy of the original Card Deck reference manual. This may be done by writing to the Director, National Weather Records Center, Asheville, North Carolina.

Care should be taken to read carefully the statements pertaining to observational quality, general tape notations, common coding practices and conversion procedures used for the individual decks.

TAPE DECK		PAGE NO.
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THE DATA FILE

Over 31 million Surface Marine observations are currently in Tape Data Family - 11. They are filed by 10° Marsden Square, Year, Month without regard to individual deck number. ie: All observations for January 1962 in Marsden Square 051 would be found together, followed by all observations for February 1962 etc. The period 1800- June,1968 is held on 293 reels of 9 channel, 800 bpi tape. It is not anticipated that future acquisitions will be merged into this group, but will be placed on tape in the TDF-11 format and retained as a separate file.

Observations from Ocean Weather Staions were placed in the TDF-11 format but not merged into the common file mentioned above. Currently operating Weather Ships are kept, individually, by station number (See Tape Field 029), while those ships no longer actively reporting have been filed together. Observations are filed by Ocean Weather Station number, Year, Month. These reports were also taken from a variety of card decks.

Funding for the development of TDF-11 was provided jointly by the Naval Weather Service Command, the Environmental Science Services Administration, and the Department of Defense.

SPECIAL NOTE

Although every effort was made to assure conformity, the user is cautioned that discrepencies in original punching procedures and conversion schemes occasionally occurred. Validity checks should be applied to all elements as they are used.

Reporting practices for individual decks sometimes varied during the applicable period. It must not be assumed that all elements are available for each observation. For example: A specific deck may report Present Weather for only 15 years out of a 40 year period of record. Documentation of these vagaries was not sufficient enough to allow us to include such items in this manual.

Not all ships changed their reporting practices to conform to the codes effective January 1, 1968, on that date. In many cases it was impossible to determine whether the new or old codes were being reported. This situation continued for the first few months of 1968. The Wave and Swell groups, in particular, should be examined closely during this period.

MANUAL AND TAPE NOTATIONS

FORMAT

Each observation is 140 characters in length. Positions 001-082 and 89-93 are common to all decks. Positions 083-088 vary according to the indicator found in position 082. Positions 094-140 are reserved for Supplemental Data and may be different for each deck. Because of the wide variety of elements and coding vagaries inherent in the Supplemental Data Fields, it is expected that most users will restrict themselves to working with the common portion of the observations.

For quick reference, each element or group of similar elements is identified by a Field Number. Thus, Fields 001-032 and 037-038 are common to all decks, Fields 033-036 vary according to the indicator found in Field 032,and Fields 039-onward are reserved for Supplemental Data.

The manual consists of five basic parts:

1. General Information
2. The Standard Format with definitions of Tape Fields and Positions
3. The basic codes used for all elements in the common portion of the observations
4. Explanations of Unique Characteristics, Conversion Procedures and Supplemental Data Fields by individual deck
5. General coding practices, conversions and formulae used during the conversion from cards to tape. (Section 4).

When an element is shown as being available but no conversion procedure is noted - the codes were deemed compatible and the punched values transferred directly to the tape.

TAPE

The following notations are used throughout the manual:

x = any numeric digit or alpha numeric character

i = same as x but used to show that the character is an indicator rather than part of the recorded element

- = an "11" punch in the card or the equivalent tape configuration

+ = a "12" punch in the card or the equivalent tape configuration. Both the - and + may appear by themselves or in combination with a numeric digit to indicate an overpunch or signed tape field.

Δ = Blank - no card punch or blank configuration on tape

Low order = Rightmost position of a field

High order = Leftmost position of a field

When elements were not reported, not readily convertible to the common portion, or did not pass the various quality control checks, the respective tape positions in the common portion appear as blanks.

TAPE DECK		PAGE NO.
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TAPE DECK LIST

TAPE DECK NUMBER	SOURCE CARD DECK	ORIGINAL SOURCE	GENERAL PERIOD OF RECORD
1110	110	U.S. Navy Marine Observations	1945 - 1951
1116	116	U.S. Merchant Marine	1949 - 1963
1118	118	Japanese Ship Observations No. 1	1933 - 1953
1119	119	Japanese Ship Observations No. 2	1953 - 1961
1128	128	International Marine Observations	1963 -
1181	281	U.S. Navy MAR Marine Observations	1920 - 1945
1184	184	Great Britain Marine Observations	1953 - 1956
1185	185	U.S.S.R. Marine Synoptic Observations	1957 - 1958
1187	187	Japanese Whaling Fleet Observations	1946 - 1956
1188	188	Norwegian Whaling Fleet Observations	1932 - 1939
1189	189	Netherlands Marine Observations	1939 - 1955
1192	192	Deutsche Seewarte Marine Observations	1859 - 1939
1193	193	Netherlands Marine Observations	1854 - 1938
1194	194	Great Britain Marine Observations	1856 - 1953
1195	195	U.S. Navy Ship Logs	1942 - 1945
1196	196	Deutsche Seewarte Marine Observations	1949 - 1954
1197	197	Danish Marine Observations (Arctic and Antarctic)	1860 - 1956

TAPE DECK		PAGE NO.
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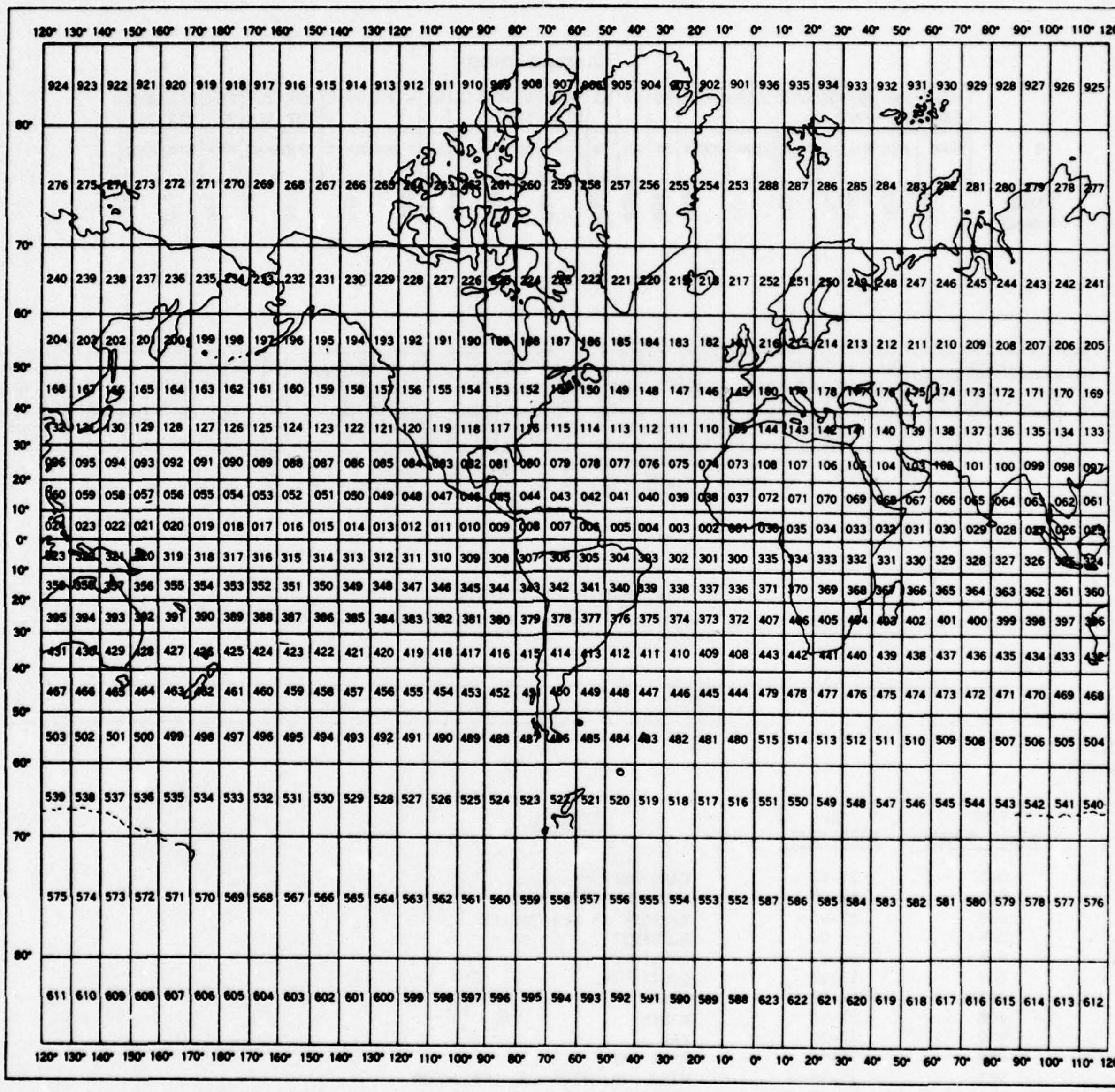
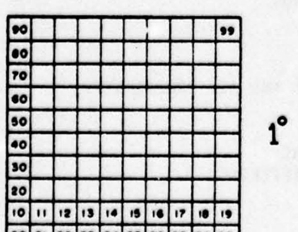
MARSDEN SQUARE NUMBERING SYSTEM





SQUARES ARE ALWAYS ORIENTED SO THAT THE LOWEST NUMBER IS NEAREST THE INTERSECTION OF THE GREENWICH MERIDIAN AND THE EQUATOR.

TAPE DECK	SURFACE MARINE OBSERVATIONS	PAGE NO.
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STANDARD FORMAT

	CARD DECK	MAR SQ	SUB SQ	Q	LAT	LONG	YEAR	MO	DA	HR	WIND DIR	WIND SPD	VIS	WX	W	PRESS	T I	AIR TMP	WET BLB	DEW PT	SEA TMP	A-S DIF
	xxx	xxx	xx	x	xxx	xxxx	xxxx	xx	xx	xx	ixx	ixxx	ixx	xx	x	xxxxx	i	xxx	xxx	xxx	xxx	xxx
FIELD NUMBER	001	002	003	004	005	006	007	008	009	010	011	012	013	014	015	016		017	018	019	020	021

	CLOUDS N	N_h	C_L	I	h	C_M	C_H	WAVE DIR	PER	WAVE HGT	SWL DIR	PER	SWL HGT	OSV NO.	CD	SHP
	x	x	x	i	x	x	x	xx	x	xx	xx	x	xx	xx	x	x
FIELD NUMBER							022	023	024	025	026	027	028	029	030	031

ADD	ICE	ICE THK	ACC	
1	x	xx	x	ΔΔ
032	033	034	035	036

ADD	DIR	SPD	a	ppp
6	x	x	x	xxx
032	033	034	035	036

ADD	SIG N	SIG T	SIG HGT	
8	x	x	xx	Δ Δ
032	033	034	035	036

ICE	SHIP NO.
x	xxxx
037	038

SUPPLEMENTAL DATA FIELDS

FIELD NUMBER

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT
001	01-03	CARD DECK NUMBER
002	04-06	MARSDEN 10° SQUARE
003	07-08	MARSDEN 1° SUB-SQUARE
004	09	QUADRANT
005	10-12	LATITUDE
006	13-16	LONGITUDE
007	17-20	YEAR
008	21-22	MONTH
009	23-24	DAY
010	25-26	HOUR-GMT
011	27-29	WIND DIRECTION AND INDICATOR
012	30-33	WIND SPEED AND INDICATOR
013	34-36	VISIBILITY AND INDICATOR
014	37-38	PRESENT WEATHER
015	39	PAST WEATHER
016	40-44	SEA LEVEL PRESSURE
017	45-48	TEMPERATURES INDICATOR AND AIR TEMPERATURE
018	49-51	WET BULB TEMPERATURE
019	52-54	DEW POINT TEMPERATURE
020	55-57	SEA SURFACE TEMPERATURE
021	58-60	AIR-SEA TEMPERATURE DIFFERENCE

TAPE DECK		PAGE NO.
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TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT
022	61	TOTAL CLOUD AMOUNT
022	62	LOWER CLOUD AMOUNT
022	63	TYPE OF LOW CLOUD
022	64	CLOUD HEIGHT INDICATOR
022	65	CLOUD HEIGHT
022	66	TYPE OF MIDDLE CLOUD
022	67	TYPE OF HIGH CLOUD
023	68-69	DIRECTION OF WAVES
024	70	PERIOD OF WAVES
025	71-72	HEIGHT OF WAVES
026	73-74	DIRECTION OF SWELL
027	75	PERIOD OF SWELL
028	76-77	HEIGHT OF SWELL
029	78-79	OCEAN WEATHER STATION NUMBER
030	80	CARD INDICATOR
031	81	OSV OR SHIP INDICATOR
032	82	ADDITIONAL DATA INDICATOR

WHEN ADDITIONAL DATA INDICATOR = Δ

033-036	83-88	BLANK

WHEN ADDITIONAL DATA INDICATOR = 1

033	83	TYPE OF ICE
034	84-85	THICKNESS OF ICE
035	86	RATE OF ICE ACCRETION
036	87-88	BLANK

WHEN ADDITIONAL DATA INDICATOR = 6

033	83	SHIP DIRECTION
034	84	SHIP SPEED
035	85	BAROMETRIC TENDENCY
036	86-88	AMOUNT OF PRESSURE CHANGE

WHEN ADDITIONAL DATA INDICATOR = 8

033	83	SIGNIFICANT CLOUD AMOUNT
034	84	SIGNIFICANT CLOUD TYPE
035	85-86	SIGNIFICANT CLOUD HEIGHT
036	87-88	BLANK
037	89	ICE INDICATOR
038	90-93	SHIP NUMBER
039 -	94-140	SUPPLEMENTAL DATA FIELDS

TAPE DECK		PAGE NO.
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STANDARD FORMAT CODES

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
001	01-03	CARD DECK NUMBER	000-999	Number of the punched card deck from which the observation came.
002	04-06	10° MARSDEN SQUARE	001-936	See explanation of Marsden Square system in the Introduction.
003	07-08	1° MARSDEN SUB-SQUARE	00-99	See explanation of Marsden Square system in the Introduction.
004	09	QUADRANT	1-4	1 = N Latitude and W Longitude 2 = N Latitude and E Longitude 3 = S Latitude and W Longitude 4 = S Latitude and E Longitude
005	10-12	LATITUDE	000-900	00.0° - 90.0° North or South
006	13-16	LONGITUDE	0000-1800	000.0° - 180.0° East or West
007	17-20	YEAR	18xx-19xx	xx = Any number.
008	21-22	MONTH	01-12	01 = January 07 = July 02 = February 08 = August 03 = March 09 = September 04 = April 10 = October 05 = May 11 = November 06 = June 12 = December
009	23-24	DAY	01-31	Day of the month
010	25-26	HOUR - GMT	00-23	0000 GMT - 2300 GMT
011 i	27	WIND DIRECTION INDICATOR	Δ,0,1,2	Δ = 36 point scale 0 = 32 point scale 1 = 16 of 36 point scale 2 = 16 of 32 point scale
011	28-29	WIND DIRECTION	00-36,99	Direction from which the wind is blowing.

	36Pt	32Pt	16of36Pt.	16of32Pt
00 =	Calm	Calm	Calm	Calm
01 =	005-014°	006-016°		
02 =	015-024°	017-028°	012-033°	012-034°
03 =	025-034°	029-039°		
04 =	035-044°	040-050°		035-056°
05 =	045-054°	051-061°	034-056°	
06 =	055-064°	062-073°		057-079°
07 =	065-074°	074-084°	057-078°	
08 =	075-084°	085-095°		080-101°
09 =	085-094°	096-106°	079-101°	
10 =	095-104°	107-118°		102-124°
11 =	105-114°	119-129°	102-123°	
12 =	115-124°	130-140°		125-146°
13 =	125-134°	141-151°		
14 =	135-144°	152-163°	124-146°	147-169°
15 =	145-154°	164-174°		
16 =	155-164°	175-185°	147-168°	170-191°
17 =	165-174°	186-196°		
18 =	175-184°	197-208°	169-191°	192-214°

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 2

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
011	28-29	WIND DIRECTION (Cont'd)	00-36,99	

Code	36Pt	32Pt	16of36Pt	16of32Pt
19 =	185-194°	209-219°		
20 =	195-204°	220-230°	192-213°	215-236°
21 =	205-214°	231-241°		
22 =	215-224°	242-253°		237-259°
23 =	225-234°	254-264°	214-236°	
24 =	235-244°	265-275°		260-281°
25 =	245-254°	276-286°	237-258°	
26 =	255-264°	287-298°		282-304°
27 =	265-274°	299-309°	259-281°	
28 =	275-284°	310-320°		305-326°
29 =	285-294°	321-331°	282-303°	
30 =	295-304°	332-343°		327-349°
31 =	305-314°	344-354°		
32 =	315-324°	355-005°	304-326°	350-011°
33 =	325-334°			
34 =	335-344°		327-348°	
35 =	345-354°			
36 =	355-004°		349-011°	
99 =	Variable			

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
012 i	30	WIND SPEED INDICATOR	Δ,0	Δ = Not measured 0 = Measured
012	31-33	WIND SPEED	000-199	000 = Calm 001-199 = 1 to 199 Knots
013 i	34	VISIBILITY INDICATOR	Δ,0,1	Δ = Not measured 0 = Measured 1 = Fog present
013	35-36	VISIBILITY	90-99	Horizontal visibility at the surface in kilometers. 90 = <0.05 91 = 0.05 92 = 0.2 93 = 0.5 94 = 1 95 = 2 96 = 4 97 = 10 98 = 20 99 = 50 or more NOTE: When Visibility Indicator = 1, and Visibility = 93, it means that Fog was present and visibility was not reported.
014	37-38	PRESENT WEATHER	00-99	00 = Cloud development not observed. 01 = Clouds generally dissolving or becoming less developed. 02 = State of the sky unchanged. 03 = Clouds generally forming or developing. 04 = Visibility reduced by smoke 05 = Haze 06 = Widespread dust in suspension in the air, not raised by wind, at or near the station at the time of observation. 07 = Dust or sand raised by wind at or near the station at the time of observation, but no well developed dust whirls or sand whirls and no duststorm or sandstorm seen.

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 3

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
014	37-38	PRESENT WEATHER	00-99	08 = Well developed dust whirls or sand whirls seen at or near the station during the preceding hour or at the time of observation, but no duststorm or sandstorm. 09 = Duststorm or sandstorm within sight at the time of observation, or at the station during the preceding hour. 10 = Light fog (visibility 1,100 yards or more). Synonymous with European term "Mist". 11 = Patches of shallow fog or ice fog at the station,not deeper than about 10 meters. 12 = More or less continuous shallow fog or ice fog at the station,not deeper than about 10 meters. 13 = Lightning visible, no thunder heard. 14 = Precipitation within sight, not reaching the surface of the sea. 15 = Precipitation within sight, reaching the surface of the sea, but more than 5 km. from the ship. 16 = Precipitation within sight, reaching the surface of the sea, near to, but not at the ship. 17 = Thunderstorm, but no precipitation at the time of observation. 18 = Squalls at or within sight of the ship during the preceding hour or at the time of observation. 19 = Funnel cloud or Waterspout at or within sight of the ship during the preceding hour or at the time of observation. The following phenomena occurred at the ship during the preceding hour but not at the time of observation. 20 = Drizzle (not freezing) or snow grains 21 = Rain (not freezing) 22 = Snow 23 = Rain and snow or ice pellets, type(a). 24 = Freezing drizzle or freezing rain. 25 = Shower(s) of rain. 26 = Shower(s) of snow or of rain and snow. 27 = Shower(s) of hail (ice pellets, type (b), snow pellets), or of rain and hail (ice pellets, type (b), snow pellets). 28 = Fog or ice fog. 29 = Thunderstorm (with or without precipitation). Present weather codes 30-99 refer to phenomena occuring at the ship at time of observation. 30 = Slight or moderate duststorm or sandstorm has decreased during the preceding hour.

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 4

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
014	37-38	PRESENT WEATHER	00-99	31 = Slight or moderate duststorm or sandstorm no appreciable change during the preceding hour. 32 = Slight or moderate duststorm or sandstorm has begun or has increased during the preceding hour. 33 = Severe duststorm or sandstorm has decreased during the preceding hour. 34 = Severe duststorm or sandstorm no appreciable change during the preceding hour. 35 = Severe duststorm or sandstorm has begun or has increased during the preceding hour. 36 = Slight or moderate drifting snow generally low (below eye level) less than 6 feet. 37 = Heavy drifting snow generally low (below eye level) less than 6 feet. 38 = Slight or moderate blowing snow generally high (above eye level) 6 feet or more. 39 = Heavy blowing snow generally high (above eye level) 6 feet or more. 40 = Fog or ice fog at a distance at the time of observation, but not at the ship during the preceding hour, the fog or ice fog extending to a level above that of the observer. 41 = Fog or ice fog in patches. 42 = Fog or ice fog, sky visible has become thinner during the preceding hour. 43 = Fog or ice fog, sky invisible has become thinner during the preceding hour. 44 = Fog or ice fog, sky visible no appreciable change during the preceding hour. 45 = Fog or ice fog, sky invisible no appreciable change during the preceding hour. 46 = Fog or ice fog, sky visible has begun or has become thicker during the preceding hour. 47 = Fog or ice fog, sky invisible has begun or has become thicker during the preceding hour. 48 = Fog, depositing rime, sky visible. 49 = Fog, depositing rime, sky invisible. 50 = Drizzle, not freezing, intermittent slight at time of observation. 51 = Drizzle, not freezing, continuous slight at time of observation. 52 = Drizzle, not freezing, intermittent moderate at time of observation. 53 = Drizzle, not freezing, continuous moderate at time of observation. 54 = Drizzle, not freezing, intermittent heavy (dense) at time of observation. 55 = Drizzle, not freezing, continuous heavy (dense) at time of observation. 56 = Drizzle, freezing, slight. 57 = Drizzle, freezing, moderate or heavy (dense).

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 5

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
014	37-38	PRESENT WEATHER	00-99	58 = Drizzle and rain, slight. 59 = Drizzle and rain, moderate or heavy. 60 = Rain, not freezing,intermittent, slight at time of observation. 61 = Rain, not freezing, continuous, slight at time of observation. 62 = Rain, not freezing, intermittent, moderate at time of observation. 63 = Rain, not freezing, continuous, moderate at time of observation. 64 = Rain, not freezing, intermittent, heavy at time of observation. 65 = Rain, not freezing, continuous, heavy at time of observation. 66 = Rain, freezing, slight. 67 = Rain, freezing, moderate or heavy. 68 = Rain or drizzle and snow, slight. 69 = Rain or drizzle and snow, moderate or heavy. 70 = Intermittent fall of snowflakes, slight at time of observation. 71 = Continuous fall of snowflakes slight at time of observation. 72 = Intermittent fall of snowflakes moderate at time of observation. 73 = Continuous fall of snowflakes moderate at time of observation. 74 = Intermittent fall of snowflakes heavy at time of observation. 75 = Continuous fall of snowflakes heavy at time of observation. 76 = Ice prisms (with or without fog). 77 = Snow grains (with or without fog). 78 = Isolated starlike snow crystals (with or without fog). 79 = Ice pellets, type (a) (sleet, U.S. definition). 80 = Rain shower(s), slight. 81 = Rain shower(s), moderate or heavy. 82 = Rain shower (s), violent. 83 = Shower (s) of rain and snow mixed, slight. 84 = Shower (s) of rain and snow mixed, moderate or heavy. 85 = Snow shower (s), slight. 86 = Snow shower (s), moderate or heavy. 87 = Slight showers of snow pellets or ice pellets, type (b), with or without rain or rain and snow mixed. 88 = Moderate or heavy showers of snow pellets or ice pellets (b),with or without rain or rain and snow mixed. 89 = Slight showers of hail with or without rain or rain and snow mixed, not associated with thunder.

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 6

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
014	37-38	PRESENT WEATHER	00-99	90 = Moderate or heavy showers of hail, with or without rain or rain and snow, slight mixed, not associated with thunder. 91 = Slight rain at time of observation, thunderstorm during preceding hour but not at observation. 92 = Moderate or heavy rain at time of observation, thunderstorm during preceding hour but not at observation 93 = Slight snow, or rain and snow mixed or hail, at time of observation with thunderstorm during the preceding hour but not at time of observation. 94 = Moderate or heavy snow, or rain and snow mixed, or hail, at time of observation with thunderstorm during the preceding hour but not at time of observation. 95 = Thunderstorm, slight or moderate, without hail, but with rain and/or snow at time of observation. 96 = Thunderstorm, slight or moderate, with hail at time of observation. 97 = Thunderstorm, heavy, without hail but with rain and/or snow at time of observation. 98 = Thunderstorm combined with duststorm or sandstorm at time of observation. 99 = Thunderstorm, heavy, with hail at time of observation.
015	39	PAST WEATHER (The period covered by Past Weather is 6 hours for observations at 0000, 0600, 1200, and 1800 GMT and 3 hours for observations at 0300, 0900, 1500, and 2100 GMT).	0-9	0 = Cloud covering 1/2 or less of the sky throughout the appropriate period. 1 = Cloud covering more than 1/2 of the sky during part of the appropriate period and covering 1/2 or less during part of the period. 2 = Cloud covering more than 1/2 of the sky throughout the appropriate period. 3 = Sandstorm, duststorm or blowing snow. 4 = Fog or ice fog or thick haze (U.S. includes thick smoke). 5 = Drizzle 6 = Rain 7 = Snow, or rain and snow mixed. 8 = Shower 9 = Thunderstorm with or without precipitation.
016	40-44	SEA LEVEL PRESSURE	08900-10700	890.0-1070.0 millibars
017 i	45	TEMPERATURES INDICATOR	1, 3, 5	1 = Degrees Celsius and tenths 3 = Whole degrees Celsius 5 = Half degrees Celsius
017	46-48	AIR TEMPERATURE		
018	49-51	WET BULB TEMPERATURE	000-999	00.0-99.9 °C positive temperature
019	52-54	DEW POINT TEMPERATURE	or	
020	55-57	SEA SURFACE TEMPERATURE	$\overline{0}0\overline{1}-99\overline{9}$	-00.1--99.9°C negative temperature

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 7

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
021	58-60	AIR-SEA TEMPERATURE DIFFERENCE	000-999 or $\bar{0}00$-$99\bar{9}$	00.0-99.9 °C Air warmer than sea 00.0-99.9 °C Sea warmer than air
022 022	61 62	TOTAL CLOUD AMOUNT (N) LOWER CLOUD AMOUNT (N_h)	0-9	Fraction of celestial dome covered by all clouds. Fraction of celestial dome covered by all the C_L clouds and, if no C_L cloud is present, that fraction covered by all the C_M clouds present. 0 = Clear 1 = 1 Okta or less, but not zero. 2-8 = 2-8 Oktas 9 = Sky obscured or cloud amount cannot be estimated.
022	63	LOW CLOUD TYPE (C_L)	0-9, -	0 = No Stratocumulus, Stratus, Cumulus or Cumulonimbus. 1 = Cumulus with little vertical extent and seemingly flattened, or ragged Cumulus other than of bad weather, or both. 2 = Cumulus of moderate or strong vertical extent, generally with protuberances in the form of domes or towers, either accompanied or not by other Cumulus or by Stratocumulus, all having their base at the same level. 3 = Cumulonimbus the summits of which, at least partially, lack sharp outlines but are neither clearly fibrous (cirriform) nor in the form of an anvil; Cumulus, Stratocumulus or Stratus may also be present. 4 = Stratocumulus formed by the spreading out of Cumulus; Cumulus may also be present. 5 = Stratocumulus not resulting from the spreading out of Cumulus. 6 = Stratus in a more or less continuous sheet or layer, or in ragged shreads, or both, but no Stratus fractus of bad weather. 7 = Stratus fractus of bad weather (generally existing during precipitation and a short time before and after) or Cumulus fractus of bad weather, or both (pannus), usually below Altostratus or Nimbostratus. 8 = Cumulus and Stratocumulus other than that formed from the spreading out of Cumulus; the base of the Cumulus is at a different level from that of the Stratocumulus. 9 = Cumulonimbus, the upper part of which is clearly fibrous (cirriform), often in the form of an anvil; either accompanied or not by Cumulonimbus without anvil or fibrous upper part by Cumulus, Stratocumulus, Stratus or pannus. - = Stratocumulus, Stratus, Cumulus and Cumulonimbus invisible owing to darkness, fog, blowing dust or sand, or other similar phenomena.

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 8

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
022 i	64	CLOUD HEIGHT INDICATOR	Δ, 0	Δ = Height not measured 0 = Height measured
022	65	CLOUD HEIGHT (h)	0-9	Height above sea surface of the base of the lowest cloud or fragment thereof.

Code	Approximate Height in Feet	Height in Meters
0 =	0-149	0-49
1 =	150-299	50-99
2 =	300-599	100-199
3 =	600-999	200-299
4 =	1000-1999	300-599
5 =	2000-3499	600-999
6 =	3500-4999	1000-1499
7 =	5000-6499	1500-1999
8 =	6500-7999	2000-2499
9 =	$\geq$ 8000 or no clouds	$\geq$ 2500 or no clouds

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
022	66	MIDDLE CLOUD TYPE (C_M)	0-9, -	0 = No altocumulus, Altostratus or Nimbostratus. 1 = Altostratus, the greater part of which is semi-transparent; through this part the sun or moon may be weakly visible, as through ground glass. 2 = Altostratus, the greater part of which is sufficiently dense to hide the sun or moon, or Nimbostratus. 3 = Altocumulus, the greater part of which is semi-transparent; the various elements of the cloud change only slowly and are all at a single level. 4 = Patches (often in the form of almonds or fishes) of Altocumulus, the greater part of which is semi-transparent; the clouds occur at one or more levels and the elements are continually changing in appearance. 5 = Semi-transparent Altocumulus in bands, or Altocumulus in one or more fairly continuous layers (semi-transparent or opaque), progressively invading the sky; these Altocumulus clouds generally thicken as a whole. 6 = Altocumulus resulting from the spreading out of Cumulus (or Cumulonimbus). 7 = Altocumulus in two or more layers, usually opaque inplaces, and not progressively invading the sky; or opaque layer of Altocumulus, not progressively invading the sky; or Altocumulus together with Altostratus or Nimbostratus. 8 = Altocumulus with sproutings in the form of small towers or battlements; or Altocumulus having the appearance of cumuliform tufts. 9 = Altocumulus of a chaotic sky, generally at several levels. - = Altocumulus, Altostratus and Nimbostratus invisible owing to darkness, fog, blowing dust or sand or other similar phenomena, or more often because of the presence of a continuous layer of lower clouds.

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 9

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
022	67	HIGH CLOUD TYPE (C_H)	0-9, -	0 = No Cirrus, Cirrocumulus or Cirrostratus 1 = Cirrus in the form of filaments, strands or hooks, not progressively invading the sky. 2 = Dense Cirrus, in patches or entangled sheaves, which usually do not increase and sometimes seem to be the remains of the upper part of a Cumulonimbus; or Cirrus with sproutings in the form of small turrets or battlements, or Cirrus having the appearance of cumuliform tufts. 3 = Dense Cirrus, often in the form of an anvil, being the remains of the upper parts of Cumulonimbus. 4 = Cirrus in the form of hooks or of filaments, or both, progressively invading the sky; they generally become denser as a whole. 5 = Cirrus (often in bands converging towards one point or two opposite points of the horizon) and Cirrostratus, or Cirrostratus alone; in either case, they are progressively invading the sky, and generally growing denser as a whole, but the continuous veil does not reach 45 degrees above the horizon. 6 = Cirrus (often in bands converging towards one point or two opposite points of the horizon) and Cirrostratus, or Cirrostratus alone; in either case, they are progressively invading the sky, and generally growing denser as a whole; the continuous veil extends more than 45 degrees above the horizon, without the sky being totally covered. 7 = Veil of Cirrostratus covering the celestial dome. 8 = Cirrostratus not progressively invading the sky and not completely covering the celestial dome. 9 = Cirrocumulus alone, or Cirrocumulus accompanied by Cirrus or Cirrostratus, or both, but Cirrocumulus is predominant. - = Cirrus, Cirrocumulus and Cirrostratus invisible owing to darkness, fog, blowing dust or sand or other similar phenomena, or more often because of the presence of a continuous layer of lower clouds.

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 10

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
023	68-69	DIRECTION OF WAVES	00-36, 49,99	Direction from which waves come, in tens of degrees 00 = Calm 01 = 005-014° 02 = 015-024° 03 = 025-034° 04 = 035-044° 05 = 045-054° 06 = 055-064° 07 = 065-074° 08 = 075-084° 09 = 085-094° 10 = 095-104° 11 = 105-114° 12 = 115-124° 13 = 125-134° 14 = 135-144° 15 = 145-154° 16 = 155-164° 17 = 165-174° 18 = 175-184° 19 = 185-194° 20 = 195-204° 21 = 205-214° 22 = 215-224° 23 = 225-234° 24 = 235-244° 25 = 245-254° 26 = 255-264° 27 = 265-274° 28 = 275-284° 29 = 285-294° 30 = 295-304° 31 = 305-314° 32 = 315-324° 33 = 325-334° 34 = 335-344° 35 = 345-354° 36 = 355-004° 49 = Waves confused, direction indeterminate (waves equal to or less than 4 3/4 meters). 99 = Waves confused, direction indeterminate (waves greater than 4 3/4 meters).
024	70	PERIOD OF WAVES	0-9, -	2 = 5 seconds or less 3 = 6-7 seconds 4 = 8-9 seconds 5 =10-11 seconds 6 =12-13 seconds 7 =14-15 seconds 8 =16-17 seconds 9 =18-19 seconds 0 =20-21 seconds 1 =over 21 seconds - =calm or period not determined
025	71-72	HEIGHT OF WAVES	00-99	Height in 1/2 meter increments 00 = < 1/4 meter 01-99 = 1/2 - 49 1/2 meters
026	73-74	DIRECTION OF SWELL	00-36, 49,99	Same as Direction of Waves
027	75	PERIOD OF SWELL	0-9, -	Same as Period of Waves prior to 1968 Beginning January 1, 1968, the code for Period of Swell is 0 = 10 seconds 1 = 11 seconds 2 = 12 seconds 3 = 13 seconds 4 = 14 seconds or more 5 = 5 seconds or less 6 = 6 seconds 7 = 7 seconds 8 = 8 seconds 9 = 9 seconds - = calm or period not determined
028	76-77	HEIGHT OF SWELL	00-99	Same as Height of Waves

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 11

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
029	78-79	OCEAN WEATHER STATION NUMBER (Used when Field 031 = 2 or $\bar{2}$) NOTE: Other configurations may appear in this Field. These were used for control and edit procedures and have no valid meaning to the user.	ΔΔ, 01-26	Station No. / Station No. A = 01 / N = 14 B = 02 / O = 15 C = 03 / P = 16 D = 04 / Q = 17 E = 05 / R = 18 F = 06 / S = 19 G = 07 / T = 20 H = 08 / U = 21 I = 09 / V = 22 J = 10 / W = 23 K = 11 / X = 24 L = 12 / Y = 25 M = 13 / Z = 26
030	80	CARD INDICATOR	Δ,0-5, $\bar{0}$	Δ = All card decks except 128 0-5 = Card deck 128. Codes are World Meteorological Organization codes effective at time of observation. $\bar{0}$ = Card deck 128. Observations punched by U.S.
031	81	OSV OR SHIP INDICATOR	Δ, 0, 2, $\bar{2}$, 4	Δ = Navy and Deck Log Observations 0 = Merchant ships 2 = OSV - off station $\bar{2}$ = OSV - on station 4 = Lightship
032	82	ADDITIONAL DATA INDICATOR	Δ, 1, 6, 8	Δ = No additional data 1 = Ice information follows 6 = Ship direction and speed and 3 hour pressure change follows 8 = Significant cloud information follows
WHEN ADDITIONAL DATA INDICATOR = 1				
033	83	TYPE OF ICE	1-5	1 = Icing from ocean spray 2 = Icing from fog 3 = Icing from spray and fog 4 = Icing from rain 5 = Icing from spray and rain
034	84-85	ICE THICKNESS	00-99	Ice thickness in centimeters
035	86	RATE OF ICE ACCRETION	0-4	0 = Ice not building up 1 = Ice building up slowly 2 = Ice building up rapidly 3 = Ice melting or breaking up slowly 4 = Ice melting or breaking up rapidly
036	87-88	BLANK		
WHEN ADDITIONAL DATA INDICATOR = 6				
033	83	SHIP DIRECTION	0-9	Ship's course (true) made good during the 3 hours preceding the time of observation. 0 = Ship hove to / 5 = SW 1 = NE / 6 = W 2 = E / 7 = NW 3 = SE / 8 = N 4 = S / 9 = Unknown

TAPE DECK	SURFACE MARINE OBSERVATIONS	PAGE NO.
TDF-11		CODES-12

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
034	84	SHIP SPEED	0-9	Ship's average speed made good during the three hours preceding the time of observation. Prior to 1968: 0 = 0 knots; 5 = 13-15 knots 1 = 1- 3 knots; 6 = 16-18 knots 2 = 4- 6 knots; 7 = 19-21 knots 3 = 7- 9 knots; 8 = 22-24 knots 4 = 10-12 knots; 9 = >24 knots Beginning January 1, 1968: 0 = 0 knots; 5 = 21-25 knots 1 = 1- 5 knots; 6 = 26-30 knots 2 = 6-10 knots; 7 = 31-35 knots 3 = 11-15 knots; 8 = 36-40 knots 4 = 16-20 knots; 9 = >40 knots
035	85	BAROMETRIC TENDENCY	0-8	0 = Increasing, then decreasing; atmospheric pressure same or higher then 3 hours ago. 1 = Increasing, then steady; or increasing then increasing more slowly; atmospheric pressure now higher than 3 hours ago. 2 = Increasing (steadily or unsteadily) atmospheric pressure now higher than 3 hours ago. 3 = Decreasing or steady, then increasing; or increasing then increasing more rapidly; atmospheric pressure now higher than 3 hours ago. 4 = Steady; atmospheric pressure same as 3 hours ago. 5 = Decreasing, then increasing; atmospheric pressure the same or lower than 3 hours ago. 6 = Decreasing, then steady,or decreasing then decreasing more slowly; atmospheric pressure now lower than 3 hours ago. 7 = Decreasing (steadily or unsteadily) atmospheric pressure now lower than 3 hours ago. 8 = Steady or increasing, then decreasing; or decreasing then decreasing more rapidly; atmospheric pressure now lower than 3 hours ago.
036	86-88	AMOUNT OF PRESSURE CHANGE	000-299	Amount of pressure change from 3 hours ago. (Tenths of millibars). 00.0- 29.9 millibars.

WHEN ADDITIONAL DATA INDICATOR = 8

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
033	83	SIGNIFICANT CLOUD AMOUNT	0-9	Amount of individual cloud layer or mass. 0 = Clear 1 = 1 Okta or less, but not zero 2-8 = 2-8 Oktas 9 = Sky obscured or cloud amount cannot be estimated.

TAPE DECK		PAGE NO.
TDF-11	SURFACE MARINE OBSERVATIONS	CODES - 13

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT	TAPE CONFIGURATION	CODE DEFINITION AND REMARKS
034	84	SIGNIFICANT CLOUD TYPE	0-9, -	Cloud Genus 0 = Cirrus 1 = Cirrocumulus 2 = Cirrostratus 3 = Altocumulus 4 = Altostratus 5 = Nimbostratus 6 = Stratocumulus 7 = Stratus 8 = Cumulus 9 = Cumulonimbus - = Cloud not visible owing to darkness, fog, duststorms, sandstorm, or other analogous phenomena.
035	85-86	SIGNIFICANT CLOUD HEIGHT	00-50 56-99	Height of the base of the cloud layer or mass whose genus was reported in Field 034. 00 = <30 meters 01-50 = 30-1500 meters in increments of 30 meters 56-80 = 1800-9000 meters in increments of 300 meters 81-88 = 10,500-21,000 meters in increments of 1500 meters 89 = >21,000 meters 90 = <50 meters 91 = 50-100 meters 92 = 100-200 meters 93 = 200-300 meters 94 = 300-600 meters 95 = 600-1000 meters 96 = 1000-1500 meters 97 = 1500-2000 meters 98 = 2000-2500 meters 99 = >2500 meters or no clouds
036	87-88	BLANK		
037	89	ICE INDICATOR	+	Indicates that the sea ice group (C_2KD_1re) was entered on the original reporting form. This indicator used only for Card Deck 128.
038	90-93	SHIP NUMBER	0001-9999 -001--999 $\overset{+}{1}000$-$\overset{+}{9}000$	Identifying number of individual ships.
039-	94-140	SUPPLEMENTAL DATA FIELDS		

SECTION 4

CONVERSION SCALES

SCALE 1 Conversion of Octant to Quadrant (Tape Field 004).

Octant = 0 (00-90°N, 00-90°W) Quadrant = 1
Octant = 1 (00-90°N, 90-180°W) Quadrant = 1

Octant = 2 (00-90°N, 90-180°E) Quadrant = 2
Octant = 3 (00-90°N, 00-90°E) Quadrant = 2

Octant = 5 (00-90°S, 00-90°W) Quadrant = 3
Octant = 6 (00-90°S, 90-180°W) Quadrant = 3

Octant = 7 (00-90°S, 90-180°E) Quadrant = 4
Octant = 8 (00-90°S, 00-90°E) Quadrant = 4

SCALE 2 Conversion of Local Standard Time to GMT (Tape Field 010).

Starting at 008°W and working westward in 15° increments, one hour was added to the LST for each 15° of Longitude through 180°.

For example: 1 hour was added for longitudes 008°-022°W
2 hours were added for longitudes 023°-037°W
etc.

Starting at 008°E and working eastward in 15° increments, one hour was subtracted from the LST for each 15° of Longitude through 180°.

For example: 1 hour was subtracted for longitudes 008°-022°E
2 hours were subtracted for longitudes 023°-037°E
etc.

SCALE 3 Conversion of 1942 present weather code to 1960 present weather code (Tape Field 014)

1960 Code (Taped)	1942 Code	1942 Code Definition	
ΔΔ	00-03	State of the sky (not converted to tape)	
04	17	Visibility reduced by smoke	
05	05	Haze (Visibility 1000 meters or more)	
08	06	Dust devils seen	
09	12	Duststorm within sight but not at ship	
10	08	Light fog (Visibility 1000-2000 meters)	
12	40	Fog	
13	07	Distant lightning	
16	10	Precipitation within sight	
17	11	Thunder, without precipitation at the ship	
18	14	Squally weather	
18	15	Heavy squalls in last three hours	
19	16	Waterspouts seen in last three hours	
20	20	Precipitation	Within past hour but not at observation
20	21	Drizzle	"
21	22	Rain	"
22	23	Snow	"
23	24	Rain and snow mixed	"
25	25	Rain shower	"
26	26	Snow shower	"
27	27	Hail or rain and hail showers	"
28	41	Moderate fog	"
29	28	Slight thunderstorm	"
29	29	Heavy thunderstorm	"

SECTION 4

CONVERSION SCALES

SCALE 3 (Cont'd)

1960 Code (Taped)	1942 Code	1942 Code Definition
30	31	Dust or sandstorm has decreased
31	30	Dust or sandstorm
31	32	Dust or sandstorm, no appreciable change
32	33	Dust or sandstorm has increased
34	34	Line of duststorms
36	35	Storm of drifting snow
36	36	Slight storm of drifting snow, generally low
37	37	Heavy storm of drifting snow, generally low
38	38	Slight storm of drifting snow, generally high
39	39	Heavy storm of drifting snow, generally high
40	09	Fog at a distance but not at ship
41	49	Fog in patches
42	43	Fog, sky discernible, has become thinner last hour
43	44	Fog, sky not discernible, has become thinner last hour
44	45	Fog, sky discernible, no appreciable change last hour
45	42	Thick fog in last hour
45	46	Fog, sky not discernible,no appreciable change last hour
46	47	Fog, sky discernible, has begun or become thicker during last hour
47	48	Fog, sky not discernible, has begun or become thicker during last hour
50	50	Drizzle
50	51	Slight intermittent Drizzle
50	57	Drizzle and fog (A 4 was placed in field 015)
51	52	Continuous slight drizzle
52	53	Intermittent moderate drizzle
53	54	Continuous moderate drizzle
54	55	Intermittent thick drizzle
55	56	Continuous thick drizzle
58	58	Slight or moderate drizzle and rain
59	59	Thick drizzle and rain
60	60	Rain
60	61	Intermittent slight rain
60	67	Rain and fog (A 4 was placed in field 015)
61	62	Continuous slight rain
62	63	Intermittent moderate rain
63	64	Continuous moderate rain
64	65	Intermittent heavy rain
65	66	Continuous heavy rain
68	68	Slight or moderate rain and snow mixed
69	69	Heavy rain and snow mixed
70	70	Snow or snow and rain mixed
70	71	Intermittent slight snow in flakes
70	77	Snow and fog (A 4 was placed in field 015)
71	72	Continuous slight snow in flakes
72	73	Intermittent moderate snow in flakes
73	74	Continuous moderate snow in flakes
74	75	Intermittent heavy snow in flakes
75	76	Continuous heavy snow in flakes
77	78	Grains of snow
79	79	Ice crystals or frozen raindrops (U.S. Sleet)

SECTION 4

CONVERSION SCALES

SCALE 3 (Cont'd)

1960 Code (Taped)	1942 Code	1942 Code Definition
80	80	Showers
80	81	Slight or moderate rain showers
81	82	Heavy rain showers
83	85	Slight or moderate rain and snow showers
84	86	Heavy rain and snow showers
85	83	Slight or moderate snow showers
86	84	Heavy snow showers
87	87	Showers of snow pellets
89	88	Slight hail or rain and hail showers
90	89	Heavy hail or rain and hail showers
91	91	Rain, thunderstorm during last hour but not at observation
93	92	Snow or rain and snow mixed, thunderstorm during last hour but not at observation
95	90	Thunderstorm
95	93	Thunderstorm, slight, without hail but with rain or snow
95	95	Thunderstorm, moderate, without hail but with rain or snow
96	94	Thunderstorm, slight, with hail
96	96	Thunderstorm, moderate, with hail
97	97	Thunderstorm, heavy, without hail but with rain or snow
98	98	Thunderstorm combined with duststorm
99	99	Thunderstorm, heavy, with hail

NOTE:

1942 Codes:
00 Cloudless
01 Partly cloudy
02 Cloudy
03 Overcast
13 Ugly, threatening sky
19 Signs of tropical storm

Do not have comparable definitions in the 1960 code and were not converted to tape.

1960 Codes:

00	35	92
01	48	94
02	49	
03	56	
06	57	
07	66	
11	67	
14	76	
15	78	
24	82	
33	88	

Did not have comparable definitions and will not appear on tape when Field 014 was derived by Scale 3.

SECTION 4

CONVERSION SCALES

SCALE 4 Computation of Wet Bulb Temperature (Tape Field 018).
(Air Temperature 0°F and above)

$$T_{wb} = T - (.034N - .00072N\ (N-1))\ (T+T_{dp} - 2P+108)$$

Where: T_{wb} = Wet Bulb Temperature in °F
T = Dry Bulb Temperature in °F
T_{dp} = Dew Point Temperature in °F

$$N = \frac{T - T_{dp}}{10}$$

P = 29.90 inches of mercury

Where necessary, Celsius temperatures were converted to Fahrenheit temperatures before the computation was made.

Because of conversion procedures, computed wet bulb temperatures occasionally exceeded the dry bulb temperature. When the computed wet bulb temperature exceeded the dry bulb temperature by one degree Celsius or less, the temperatures were considered equal and Tape Field 018 entered to equal Tape Field 017. Wet bulb temperatures exceeding the dry bulb temperature by more than one degree Celsius were considered invalid and Tape Field 018 is blank.

SCALE 5 Conversion of Beaufort Wind Force to Knots (Tape Field 012).

Tape Entry	Beaufort Wind Force	Beaufort Limits in Knots
000	0	Calm
002	1	1 - 3
005	2	4 - 6
009	3	7 -10
013	4	11-16
018	5	17-21
024	6	22-27
030	7	28-33
037	8	34-40
044	9	41-47
052	10	48-55
062	11	56-63
068	12	64 or greater

SCALE 6 Computation of Fahrenheit temperatures to Celsius Temperatures (Tape Fields 017,018,019,020)

$$°C = (°F - 32)\ (.55555)$$

The resultant Celsius temperature was rounded to the nearest tenth before placing in the appropriate tape field.

SECTION 4

CONVERSION SCALES

SCALE 7 Conversion of Cloud Amounts from tenths of sky covered to eighths of sky covered (Tape Field 022 (N), (N_h)).

Tape Entry (Oktas)	Tenths
0	0
1	1
2	2 or 3
3	4
4	5
5	6
6	7 or 8
7	9
8	10
9	Obscured

SCALE 8 Computation of Dew Point Temperature (Tape Field 019).

When RH = 40% or more:

$$T-T_{dp} = (14.55 + .114T)x + ((2.5 + .007T)x)^3$$

When RH = Less than 40%:

$$T-T_{dp} = (14.55 + .114T)x + ((2.5 + .007T)x)^3 + (15.9 + .117T)x^{14}$$

Where: T_{dp} = Dew Point Temperature in ^oC

T = Dry Bulb Temperature in ^oC

x = 1.0 - RH

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Scientists at Woods Hole routinely collect and analyze a considerable amount of data relating to the oceans of the world. Of the many different kinds of data, one particular subset concerns those events occurring at the sea surface. A large number of sea surface environmental observations have been collected at Woods Hole. These data, and the subsequent analyses generated from the Air/Sea Heat Flux and the Climatology study projects, have been collected and archived. This document describes the W.H.O.I./Climatology and Air/Sea Interaction (WHOI/CASI) data collection and provides an initial index to its various components.

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3. Oceanic energy fluxes

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